MACHINERY

August, 1909

SIMPLIFIED GEAR FORMULAS*

HORSE-POWER, PITCH, DIAMETER, WEIGHT AND PRICE

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IT is generally conceded that the Lewis formula for the strength of gear teeth, with its accompanying tables, is the most accurate in form, as the maximum strength of each tooth is determined from its shape. It may be safely used for determining the strength of gears made by modern methods, but its tabulated form makes it difficult to use from the standpoint of the designers. It is well adapted to determine the strength of any given gear or pinion. But the reverse process—that of finding a gear suitable to meet the condition of a given horse-power and revolutions per minute is not so simple; the trial-and-error method being a lengthy one at the best. The following deductions give close and rapid approximations for preliminary work.

As both the gear and its pinion are usually made of the same material, either cast iron or cast steel, the strength of the pair is determined by the strength of its weakest member, which is the pinion when made of the same metal as the gear. For economical reasons the pinion is usually limited to about 15 teeth, so we may take that number as a convenient base. Circular pitch is used in the calculations, but the circular pitch can finally be transformed to diametral pitch if this is desired.

In a train of gears, the maximum reduction on any pair is usually taken at 4 or 5 to 1, so the number of reductions and ratios may be quickly deduced. Then the problem is usually presented as follows:

* For additional information on this subject, see "The Variation of the Strength of Gear Teeth With the Velocity," January, 1908, and articles there referred to, and Data Sheet supplement, January, 1908.

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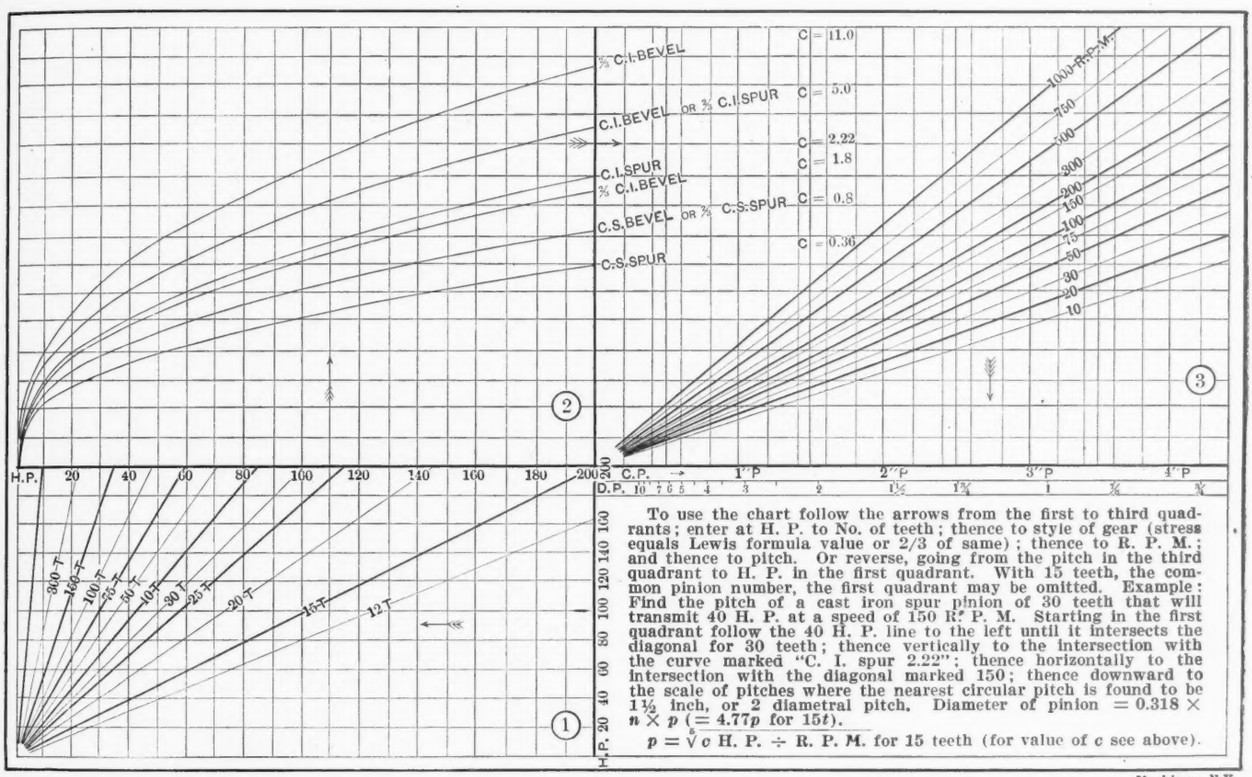
Given the H. P. and R. P. M. to find the Working Stress, Pitch, Face and Diameter

Given the horsepower and revolutions per minute of the pinion, what will be the allowable working stress, pitch, face, factor of strength and diameter?

The majority of trade gear lists give the horsepower of gears at 100 r. p. m. with an allowable stress for cast iron of 3,000 pounds per square inch. But it is more difficult to transform this horsepower to suit the other conditions, than to proceed independently.



To use the chart follow the arrows from the first to third quadrants; enter at H. P. to No. of teeth; thence to style of gear (stress equals Lewis formula value or 2/3 of same); thence to R. P. M.; and thence to pitch. Or reverse, going from the pitch in the third quadrant to H. P. in the first quadrant. With 15 teeth, the common pinion number, the first quadrant may be omitted. Example: Find the pitch of a cast iron spur pinion of 30 teeth that will transmit 40 H. P. at a speed of 150 R. P. M. Starting in the first quadrant follow the 40 H. P. line to the left until it intersects the diagonal for 30 teeth; thence vertically to the intersection with the curve marked "C. I. spur 2.22"; thence horizontally to the intersection with the diagonal marked 150; thence downward to the scale of pitches where the nearest circular pitch is found to be 1½ inch, or 2 diametral pitch. Diameter of pinion $= 0.318 \times n \times p$ ($= 4.77p$ for 15t).

$p = \sqrt[5]{c}$ H. P. ÷ R. P. M. for 15 teeth (for value of c see above).

Machinery, N.Y.

Three Quadrant Gear Chart for Solution of Spur and Bevel Gear Problems, based on Lewis Formula $M = s\,p\,f\,y$; for 15-degree Involute and Cycloidal Teeth

Let v = speed of teeth in feet per minute and s = safe working stress, then

For v =	100 (or less)	200	300	600	900	1,200	1,800	2,400
For cast iron: s =	8,000	6,000	4,800	4,000	3,000	2,400	2,000	1,700
For cast steel: s =	20,000	15,000	12,000	10,000	7,500	6,000	5,000	4,300

When these values are plotted, it will be seen that the curves, though slightly irregular, closely approximate curves of the hyperbolic form. The equations of the curves which most nearly agree with the Lewis values, are found to be the following:

$$\text{For cast iron, } s = \frac{88{,}000}{\sqrt{v}}.$$

$$\text{For cast steel, } s = \frac{220{,}000}{\sqrt{v}}.$$

These formulas give the following comparative values:

When $v =$	100	200	300	600	900	1,200	1,800	2,400
For cast iron: $s =$	8,800	6,250	5,000	3,600	2,930	2,540	2,080	1,790
For cast steel: $s =$	22,000	15,625	12,500	9,000	7,325	6,350	5,200	4,475

The agreement with the Lewis assumed values is remarkably close. The new values will probably come much nearer the true ones, as they are in much better line. They are also much more dependable, as the stress suitable for any speed can be easily found from the formula to the fraction of a pound if desired, on a true curve; whereas, the use of the tabular values results in the substitution of values which descend by variable steps of from 2,000 to 300 pounds at a jump, or if ordinary interpolation is used the result is still inaccurate, as the interpolation necessarily follows a straight line between the two nearest values, and is thus too high. The new curve values also come nearer to the comparative Harkness values as given by Kent.

The face of gears, f, is another variable quantity; but in the manufacturer's standard lists of to-day the face is usually about 3 times the pitch, and this may be adopted as close enough for preliminary work. It will be found that the majority of stock gears have either 15-degree involute or cycloidal teeth, so these styles will be used in these calculations. The factor of strength, y, in the Lewis tables for a 15-tooth pinion of these types is 0.075. We have, therefore, the following data for a 15-tooth cast iron spur pinion:

Let s = safe working stress, in pounds;
p = circular pitch, in inches;
f = face, in inches;
y = factor of strength;
v = speed of pitch line, in feet per minute.

The Lewis general formula reduces to

$$\text{H. P.} = \frac{spfyv}{33{,}000}.$$

From our average determination above, we have:

$$s = \frac{88{,}000}{\sqrt{v}},$$

$$f = 3\,p,$$

$$y = 0.075.$$

Substituting these values in the general formula and reducing, we have for a 15-tooth cast iron spur pinion:

$$\text{H. P.} = 0.6\,p^2\sqrt{v} \quad \ldots\ldots (1)$$

By a similar process, we find for a 15-tooth cast steel spur pinion:

$$\text{H. P.} = 1.5\,p^2\sqrt{v} \quad \ldots\ldots (2)$$

For a bevel pinion, let

d = small diameter of bevel,
D = large diameter of bevel.

$$\text{Then H. P.} = \frac{spfyv}{33{,}000} \times \frac{d}{D}.$$

As $\frac{d}{D}$ usually equals $\frac{2}{3}$, we can say:

$$\text{H. P.} = \frac{spfyv}{33{,}000} \times \frac{2}{3},$$

and for a 15-tooth cast iron bevel pinion,

$$\text{H. P.} = 0.4\,p^2\sqrt{v} \quad \ldots\ldots (3)$$

For a 15-tooth cast steel bevel pinion,

$$\text{H. P.} = p^2\sqrt{v} \quad \ldots\ldots (4)$$

We now wish to find v in terms of revolutions per minute. For a 15-tooth pinion, approximately:

$$v = \frac{15 \times \text{r.p.m.} \times p}{12} = 1.25 \text{ r.p.m.} \times p.$$

Substituting this value in (1) we have:

$$\text{H. P.} = 0.6\,p^2\sqrt{1.25 \text{ r.p.m.} \times p}.$$

Squaring, $\text{H. P.}^2 = 0.36\,p^4\,(1.25 \text{ r.p.m.} \times p)$.

Reducing, and solving for p, we have for cast iron spur pinion:

$$p = \sqrt[5]{\frac{2.22\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \ldots\ldots (5)$$

A similar substitution and reduction in formulas Nos. (2) (3) and (4) gives the following:

$$\text{For c. s. spur, } p = \sqrt[5]{\frac{0.36\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \ldots\ldots (6)$$

$$\text{For c. i. bevel, } p = \sqrt[5]{\frac{5.0\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \ldots\ldots (7)$$

$$\text{For c. s. bevel, } p = \sqrt[5]{\frac{0.8\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \ldots\ldots (8)$$

For rapidly varying loads, or where there is much starting and stopping, it is well to reduce the safe stress to two-thirds that allowed by the above formulas. We then have:

$$\text{For c. i. spur, H. P.} = 0.4\,p^2\sqrt{v};\ p = \sqrt[5]{\frac{5\ \text{H. P.}^2}{\text{r.p.m.}}} \quad (9)$$

$$\text{For c. s. spur, H. P.} = p^2\sqrt{v};\ p = \sqrt[5]{\frac{0.8\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \ldots\ldots (10)$$

$$\text{For c. i. bevel, H. P.} = 0.27\,p^2\sqrt{v};\ p = \sqrt[5]{\frac{11.0\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \ldots\ldots (11)$$

$$\text{For c. s. bevel, H. P.} = 0.67\,p^2\sqrt{v};\ p = \sqrt[5]{\frac{1.8\ \text{H. P.}^2}{\text{r.p.m.}}} \quad (12)$$

The fifth root can be easily determined by logarithms on the slide rule, or from the usual tables, but the values for the common cases are given in the following:

Corrections for Tooth Numbers

It now remains to determine the correction for different numbers of teeth.

As the teeth of pinions generally range from 12 to 30, we need not go outside these limits. Let n = number of teeth. Plotting the Lewis values for y for this case, and determining the nearest curve, we find that the straight line formula:

$y = \frac{2n + 45}{1{,}000}$ expresses this curve very closely, as will be seen by the following comparative table:

No. of Teeth, n	y by Formula	y from Lewis's Tables	No. of Teeth, n	y by Formula	y from Lewis's Tables
12	0.069	0.067	19	0.083	0.087
13	0.071	0.070	20	0.085	0.090
14	0.073	0.072	21	0.087	0.092
15	0.075	0.075	23	0.091	0.094
16	0.077	0.077	25	0.095	0.097
17	0.079	0.080	27	0.099	0.100
18	0.081	0.083	30	0.105	0.102

Therefore, for other teeth, we can multiply the horsepower given in the above formulas by $\frac{2n + 45}{75}$, or more briefly, by $0.027\,n + 0.6$.

Correction for Increased Velocity

We must also correct for the increased velocity of this larger pinion, *i. e.*, multiply the result by $\sqrt{\frac{n}{15}}$ or $0.26\sqrt{n}$. The continued product of these last two multipliers might be used, but this does not simplify the calculation. These corrections need seldom be applied for preliminary work.

To Find the Pinion Diameter

Lastly, to find the diameter of the pinion, approximately:

$$\text{diameter} = \frac{n \times p}{\pi}, \text{ or}$$

$$\text{diameter} = 0.318\,n\,p,$$

or for a 15-tooth pinion,

$$\text{diameter} = 4.77\,p \quad \ldots\ldots (13)$$

If diametral pitch is desired, it is sufficiently close to say:

$$\text{diametral pitch} = \frac{3}{p} \quad \ldots\ldots (14)$$

The following formulas, therefore, Nos. (5) to (14) (as deduced above), give closely enough for all preliminary determinations, the size of pinion required of 15 teeth.

	Stress = Lewis' Tables	Stress = ⅔ Lewis' Tables
c. i. spur, $p =$	$\sqrt[5]{\frac{2.22 \text{ H. P.}^2}{\text{r.p.m.}}}$	$\sqrt[5]{\frac{5.0 \text{ H. P.}^2}{\text{r.p.m.}}}$
c. s. spur, $p =$	$\sqrt[5]{\frac{0.36 \text{ H. P.}^2}{\text{r.p.m.}}}$	$\sqrt[5]{\frac{0.8 \text{ H. P.}^2}{\text{r.p.m.}}}$
c. i. bevel, $p =$	$\sqrt[5]{\frac{5.0 \text{ H. P.}^2}{\text{r.p.m.}}}$	$\sqrt[5]{\frac{11.0 \text{ H. P.}^2}{\text{r.p.m.}}}$
c. s. bevel, $p =$	$\sqrt[5]{\frac{0.8 \text{ H. P.}^2}{\text{r.p.m.}}}$	$\sqrt[5]{\frac{1.8 \text{ H. P.}^2}{\text{r.p.m.}}}$

$$\text{diameter} = 4.77\ p.$$

$$\text{diametral pitch} = \frac{3}{p}.$$

Practically, stock gears are made up to 3 inches circular pitch by ¼-inch steps, and a pitch of less than 1 inch is seldom used.

The following table will therefore determine the roots for the nearest common pitch.

No. or Root	Fifth Power	No. or Root	Fifth Power	No. or Root	Fifth Power
¾	0.24	2	32	3½	525
1	1	2¼	58	4	1,024
1¼	3	2½	98	4½	1,845
1½	8	2¾	158	5	3,125
1¾	16	3	243	5½	5,033
				6	7,776

In case the revolutions per minute of the pinion are less than 80, which is exceptionally slow, care must be taken in applying the formula, or the allowable stress may be exceeded. With a 15-tooth pinion:

80 r.p.m. = 100 feet per minute for 1-inch p.
40 r.p.m. = 100 feet per minute for 2-inch p.
27 r.p.m. = 100 feet per minute for 3-inch p.
20 r.p.m. = 100 feet per minute for 4-inch p.

Chart for Rapid Solution of Gear Problems

I have prepared a simple three quadrant chart for the rapid solution of these problems by mere inspection, good for any number of teeth, and for all the different styles, materials, and stresses of gears given by the above formulas, but for occasional preliminary determination, the formulas are sufficient, as their solution is simple. For working drawings, if the proportions vary from those assumed above, the dimensions should be checked by the more extended data in Kent's handbook, or by the use of a special chart.

It will, of course, be understood that the teeth considered in these formulas are those of the usual standard dimensions, in which the height of tooth equals seven-tenths of the pitch. What are known as "short tooth gears," in which the height of tooth equals half the pitch, are undoubtedly stronger, but their smaller working face is supposed to cause more rapid wear, and their use is not common. Although machine-molded cast gears run quietly at low speeds, they should not be used for rim speeds much over 1,000 feet per minute. For speeds of from 1,000 to 3,000 feet per minute cut gears should be substituted.

For a quick approximation of the diameter of the pinion shaft in inches:

$$\text{Shaft diameter} = p + 1.$$

The weight of pinions and gears varies with different makers. Pinions of from 12 to 30 teeth are usually made slightly wider than gears, even if they are not shrouded; and the smaller sizes have solid webs in place of arms. It is found that a formula of the form

$$\text{Weight in pounds} = \text{coefficient} \times p^2\ f\ n,$$

will usually fit the weights.

For many tables, the coefficients of the following values will serve:

$$\text{Weight of pinion} = 0.35\ p^2\ n\ f,$$
$$\text{Weight of gear} = 0.45\ p^2\ n\ f,$$

or where $f = 3\ p$,

$$\text{Weight of pinion} = p^3\ n,$$
$$\text{Weight of gear} = 1.35\ p^3\ n.$$

or when diameter and p are known, as $n = \frac{\pi\ d}{p}$,

$$\text{Weight of pinion} = 3.1\ d\ p^2,$$
$$\text{Weight of gear} = 4.2\ d\ p^2.$$

The price of gears varies largely with different manufacturers. The price of cast tooth spur gears can be usually expressed by a formula of the following form:

$$\text{Price} = (\text{coeff.} \times p\ n) + (\text{coeff.} \times p).$$

Cut tooth gears usually cost about 20 per cent more than cast tooth; and cast steel gears from 50 to 75 per cent more than cast iron gears of the same size.

* * *

TOOL-MAKERS' FILES—HOW TO ORDER

Almost every tool-maker knows from experience that an order calling for an assortment of files which merely states the length, shape and cut will rarely bring him the files he wants, unless he specifies the brand or maker's name. There are differences in makes of files which often make it impossible to use the files secured on the order, although they may be nominally what are called for. The following information regarding tool-makers' files received from the American Swiss File & Tool Co., 24 John St., New York, therefore will doubtless be appreciated by many tool-makers and others who have been troubled by inability to get exactly the files they desire.

The most marked difference in files has heretofore been found between those of domestic manufacture and imported Swiss files, appropriately called by their makers, "files of precision." But as these files of precision are now successfully produced in the United States, the terms "domestic" and "imported" have largely lost their significance as designating two distinct classes of files.

The ordinary domestic files range in length from 3 to 25 inches, and are made in five cuts, which are designated as "rough," "bastard," "second-cut," "smooth," and "super-smooth," while tool-makers' files are made in sizes from 2 to 12 inches in length and in eleven cuts, the cuts not being named but numbered. The first five numbers correspond approximately in fineness (the number of teeth to the inch) to the domestic files as follows: No. 000 same as "rough"; No. 00 same as "bastard"; No. 0 same as "second-cut"; No. 1 same as "smooth"; No. 2 same as "super-smooth." All tool-makers' file cuts above No. 2 to No. 8 have no equivalent in ordinary files.

The exact number of teeth per inch varies in both classes of files and with the different makes of the same class, but not sufficiently to make the difference noticeable until the file is used. To avoid mistakes in ordering files of precision, the order should invariably specify tool-makers' files.

* * *

In a short article in *Technik und Wirtschaft* for May, 1909, Mr. H. Noelke of Tokio, Japan, reviews the Japanese machine trade during 1908. The value of the imports of machines and tools, in round figures, from the leading industrial countries were as follows: From Great Britain, $10,500,000; from the United States, $4,600,000; from Germany, $2,250,000. Locomotives were imported from Great Britain valued at $500,000, and from the United States valued at $1,200,000. The value of the total imports of various classes of machine tools were as follows: Planers, $180,000; shapers, $18,000; slotters, $33,000; milling machines, $250,000; lathes, $475,000; automatic screw machines, $135,000; drill presses and boring mills, $425,000. The total value of the imports of machine tools amounted to about the same as the imports in 1907.

* * *

Nickel-chrome rails are, at the present time, attracting the attention of a number of the railroad companies, and the Bethlehem Steel Co. has furnished several lots of these rails to the Lehigh Valley, the Lackawanna, and other companies. While definite information concerning the experience with these rails has not been made public, it is understood that they apparently give at least three times the service of the ordinary Bessemer rail now sold at $28 a ton. As the nickel-chrome rail is sold at $51 per ton, a distinct saving is apparent wherever the traffic is heavy. The nickel and chrome produce a rail of great toughness and coarse grain, and the high carbon content which it is possible to use in connection with these two elements make the rail very hard.

Fig. 1. Getting a Heavy Frame ready for Welding

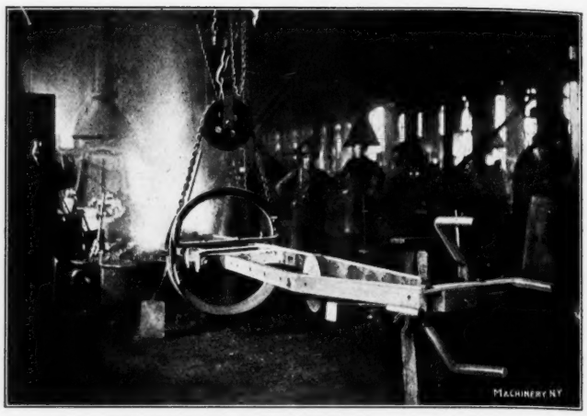


Fig. 2. The Apparatus used to handle Locomotive Frames in the Blacksmith Shop

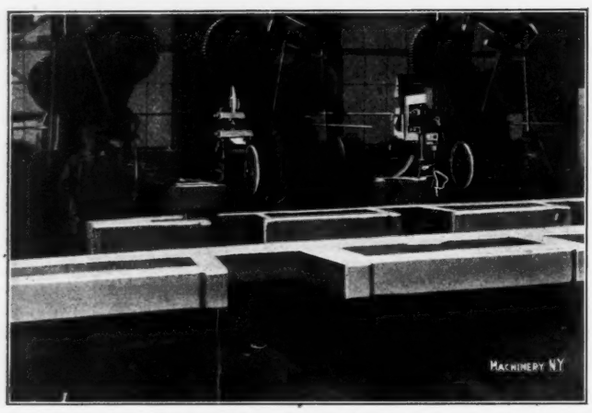


Fig. 3. Three-head Slotter which machines from Two to Four Locomotive Frames simultaneously

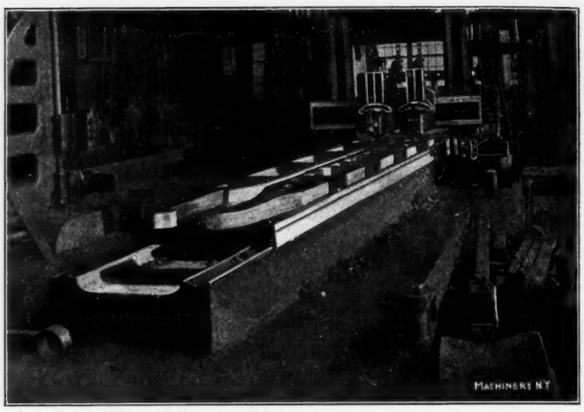


Fig. 4. Planing Locomotive Frames on a 74-inch by 38-foot Niles-Bement-Pond Planer

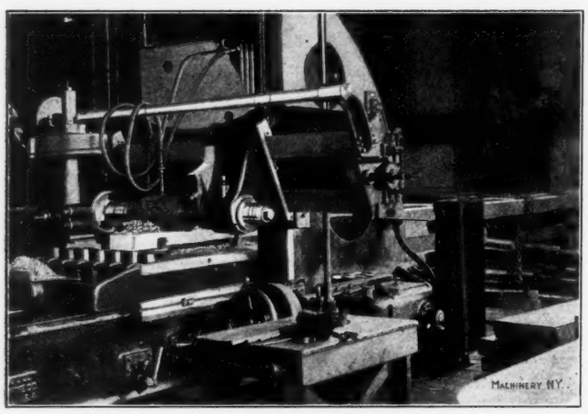


Fig. 5. Milling a ½ by 38½-inch Offset on the Front End of a Frame

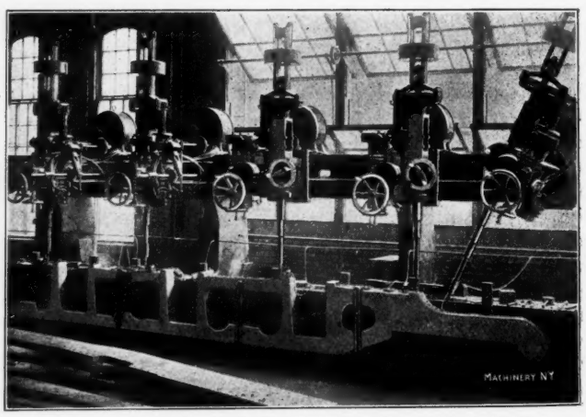


Fig. 6. Five-spindle Drill at work on a Locomotive Frame

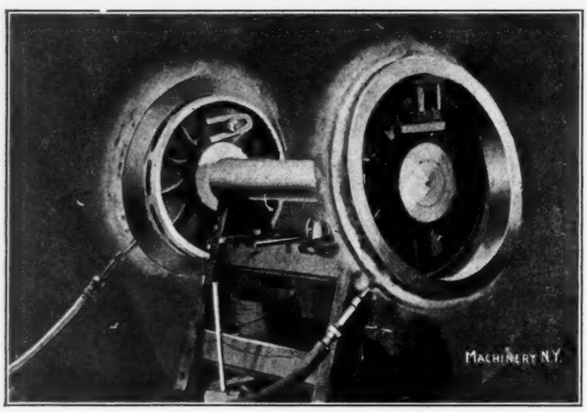


Fig 7. Heating Two Tires simultaneously with a Gas Heater

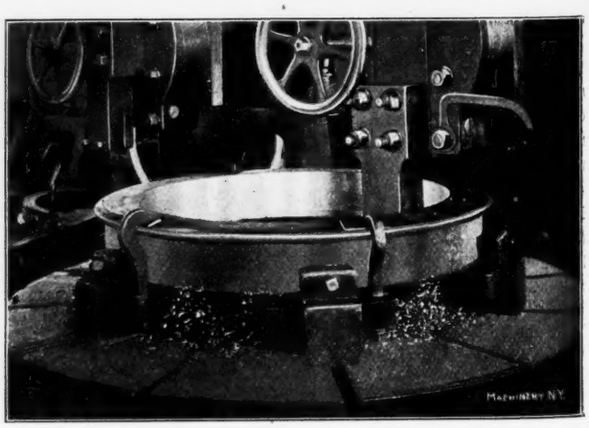


Fig. 8. Boring Locomotive Tires which are held by Hook-bolts

LOCOMOTIVE REPAIR SHOP PRACTICE—1

THE C. M. & ST. P. R.R. SHOPS AT MILWAUKEE*

ETHAN VIALL†

It is always interesting to note the various ways in which the same class of material is handled in different shops. For instance, one shop may do a majority of the work on lathes, while another a few blocks or a few miles away, will machine exactly the same parts in less time on drill-presses, or perhaps the first shop may mill everything while the second uses planers or shapers for the same operations. Of course this difference is sometimes a case of necessity rather than choice, as a shop is often originally planned and equipped for an entirely different class of work than that for which it is finally used, but even where shops have been fitted up expressly for certain similar lines of work, the divergence in methods or tools is often very marked. Railroad shops, as a rule, are of a class that must make the best of existing conditions, new shop equipment not being easily available, for in many cases the shops are the first and longest to suffer from hard times or the economical (?) methods of a saving regime. It is possible that this is the reason that practice in railroad shops varies as widely as it does. However, a few of the railroad companies are managed by men broad enough to see that the mechanical department is not the only place in which to try to effect a saving, and that it must have suitable machines and tools with which to turn out work quickly and in a first-class manner; consequently liberal allowances are often made for machine tool equipment.

Generally speaking, the work handled in a railroad shop is of a heavy nature, and the more practical way is to use this weight to help hold the work in position while it is being machined rather than to carry the weight suspended by heavy jigs or fixtures. It is this idea that has apparently been kept in mind in equipping the Chicago, Milwaukee & St. Paul Railroad shops at Milwaukee, Wis., and by so doing many operations have been simplified and expensive jigs

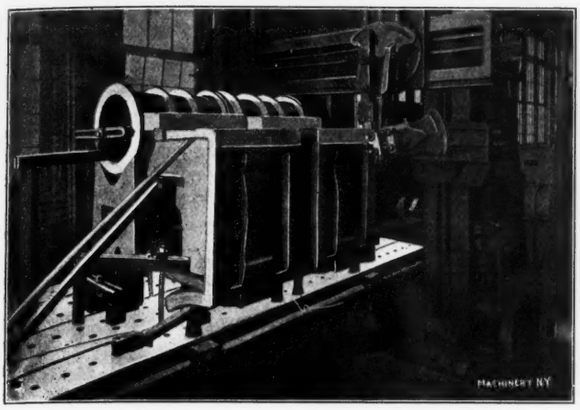


Fig. 9. Planing the Inner Faces of Two Locomotive Cylinders

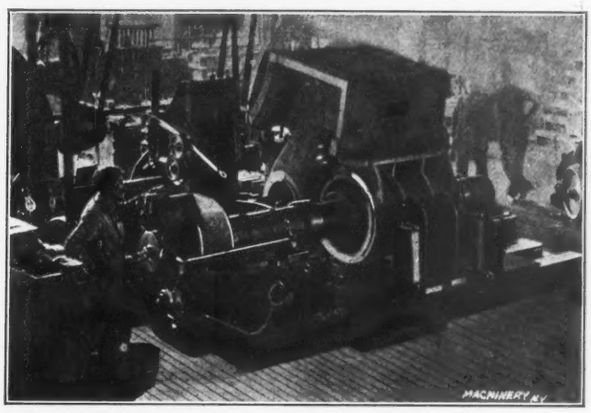


Fig. 10. Machining both Bores of a Compound Cylinder simultaneously

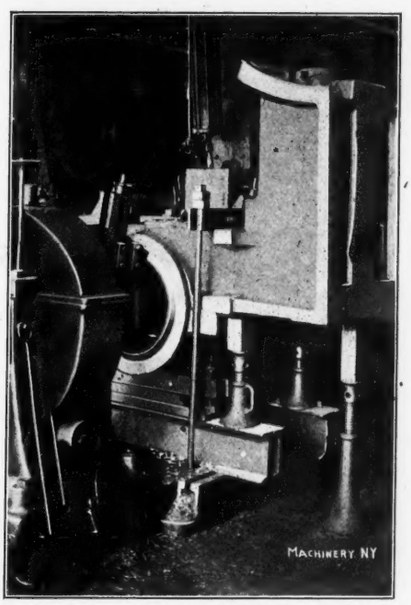


Fig. 11. Boring and Facing both Ends of a Cylinder

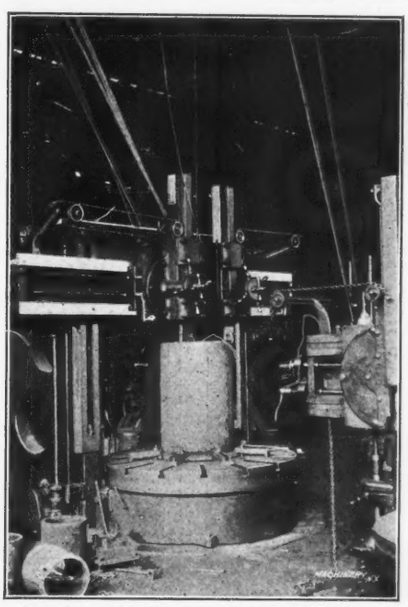


Fig. 12. Boring and turning a Cylinder Bushing

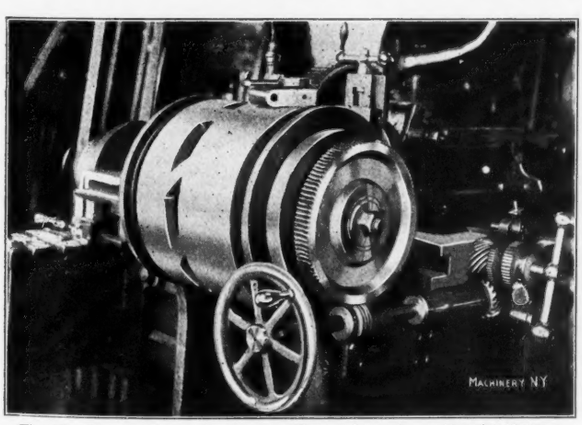


Fig. 13. Planing Valve Ports on a Shaper by using a Special Rotary Feed Attachment

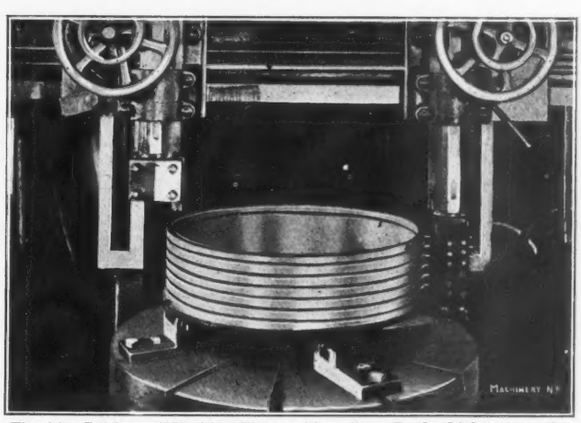


Fig. 14. Cutting off Packing Rings with a Gang Tool which severs the Rings successively from the Top

* For additional information concerning the arrangement and equipment of these shops see the articles: The Shops of the Chicago, Milwaukee & St. Paul Railway, which appeared in the January, February and March, 1904, numbers of RAILWAY MACHINERY.

† Associate Editor of MACHINERY.

or fixtures dispensed with or replaced by very simple ones. In these shops a large part of the work which other shops do on lathes, is done on boring mills, where the pieces can rest

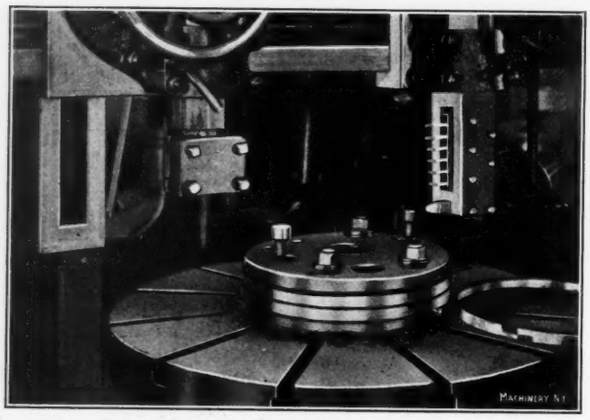


Fig. 15. Fixtures in which the Split Packing Rings are held when taking the Finishing Cut

solidly on the horizontal face-plates instead of being suspended by jigs or straps, and in consequence the time taken to place a piece in position is reduced to a minimum. Slotters

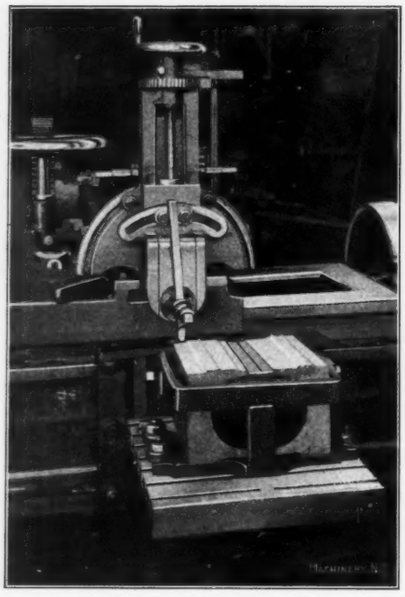


Fig. 16. Machining the Sides of Truck Cellars with Traveling Head Shaper

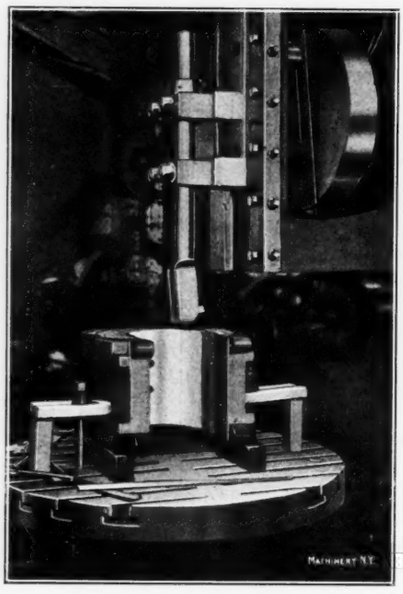


Fig. 17. Slotting the Driving-boxes for the Brasses

Fig. 18. Turning the Box Brasses on a Boring Mill

are also favorites for many jobs usually done in other shops on shapers or planers, and slotters of all makes, shapes and sizes are in evidence all through the plant.

The superintendent of motive power at the Milwaukee shops is Mr. A. E. Manchester; the master mechanic Mr. C. F. Winn, and the machine foreman in the locomotive department Mr. E. Moran, and it is to these three men that I am especially indebted for the information contained in this article. I am also under obligation to F. C. Kneller, floor foreman, C. L. Fuller, assistant to Mr. Moran, and a number of others who will be named in connection with their several departments.

Handling and Machining Frames

The principal repair work of the system is done in these shops. The locomotive frames handled vary from light to the extremely heavy ones, and Fig. 1 shows one of the largest side frames being made ready for welding in the blacksmith shop, which is in charge of A. Bennett. The method by which these frames are handled, is more clearly shown in the picture of the small one, Fig. 2. In this engraving, the way the hoist chain is applied, and the channel-rimmed wheel which is clamped around the middle of the frame, which facilitates turning the latter, and the handles clamped on the end, are clearly shown. A round weight is also shown fastened inside of the frame to balance it properly and make the handling as easy as possible. By using this apparatus the heaviest locomotive frame is handled and placed in any position as easily as if it only weighed one or two hundred pounds.

Leaving the blacksmith shop for the present, we will take up some of the operations through which the new frames pass. Fig. 3 shows a three-head Bement slotter at work on a pair of frames for one of the large types of locomotives. This slotter will machine two of the heaviest or four of the light frames at once. The slotter heads with their respective feeding mechanisms are entirely separate from each other and require an operator for each one.

Fig. 4 shows a 74-inch by 38-foot Niles-Bement-Pond planer planing the sides of two heavy frames, while Fig. 5 shows an Ingersoll miller cutting an offset of ½ inch × 38½ inches on the front end of an extra heavy frame in order to get the front deck properly in place on the engine.

Fig. 6 is a five-spindle Bement frame drill at work on a frame.

Removing and Boring Tires

The method of heating locomotive tires for removal or replacing, is about the same as that used in other large shops except that two heaters are used at once, as shown by Fig. 7, gas and compressed air being used for fuel. Tires are held on a boring mill while being bored out, in practically the same way as they are at the Northwestern shop, as was shown in the May issue, except that the centering jaws used here are specially made and the clamping hooks are tightened by nuts,

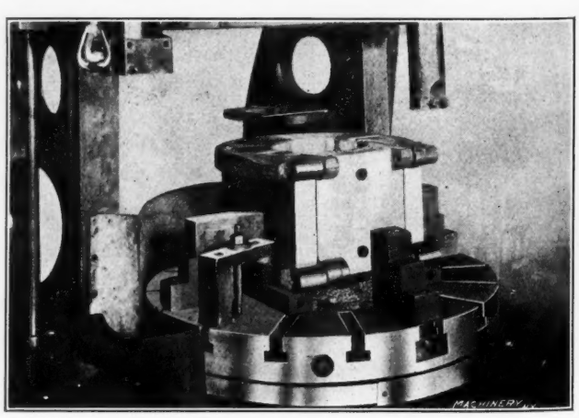


Fig. 19. Boring the Driving-box Brasses

as in Fig. 8, instead of by taper pins. Either way is quick, however, and effectually prevents springing or slipping of the tire under a heavy cut.

Machining Cylinders

In Fig. 9 is shown a Pond machine planing the back walls of two cylinders at one time, and Fig. 11 shows a machine for boring out and facing off both ends of a cylinder at once,

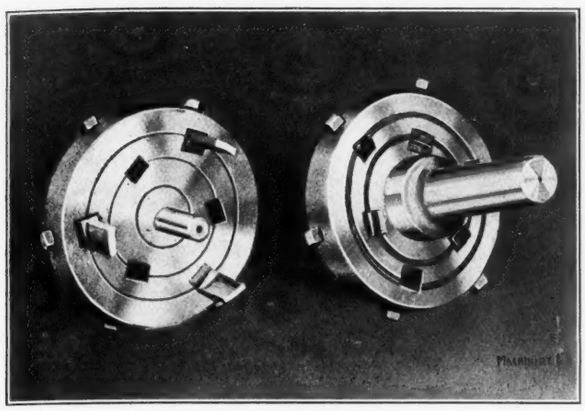


Fig. 20. Cutter Heads used for Blocking out Holes in Solid Connecting-rod Ends

while in Fig. 10 is shown a machine which will bore out both cylinders of a compound at once, though the illustration shows a job where only one boring-bar is being used. Both the inside and outside of cylinder bushings are turned at once on a boring mill, as shown in Fig. 12. This is unusual, as most

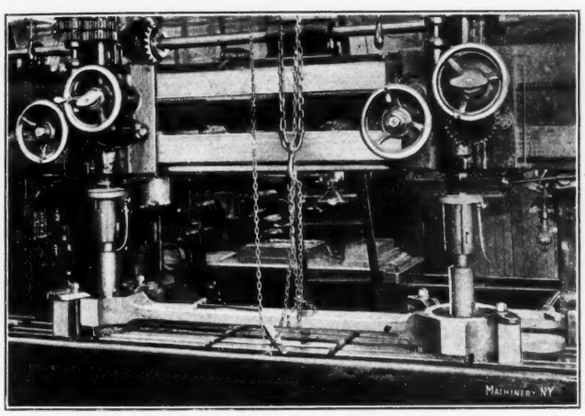


Fig. 21. Finishing the Holes in a Connecting-rod in a Two-spindle Drill Press

shops do this on lathes in two separate operations, or, if it is done on a boring mill, only one tool is used at a time in many shops.

Working out Valve Bushing Ports

In order to machine out the cored port-openings in valve-bushings, a rotary attachment has been fitted to a shaper, as shown in Fig. 13. The valve bushing is held between two

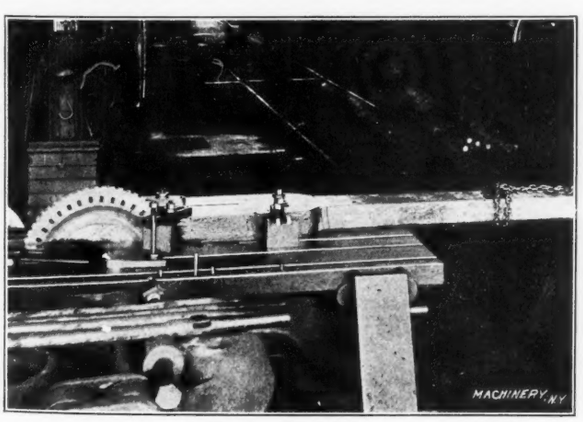


Fig. 22. Sawing out the Metal in the End of a Main-rod with a Higley Cold Saw

flanged disks, one of which is fastened to the spindle of the worm gear which runs in a bearing bracket bolted to the shaper column, while the other disk is clamped to the work by a bolt running through the middle. The outer end of this bolt is steadied by a center and bracket. The cutting is done by an extension tool held in the clapper-block shown lying on top of the bushing. This clapper-block is simply a plain block with a hole in it for the tool in place of

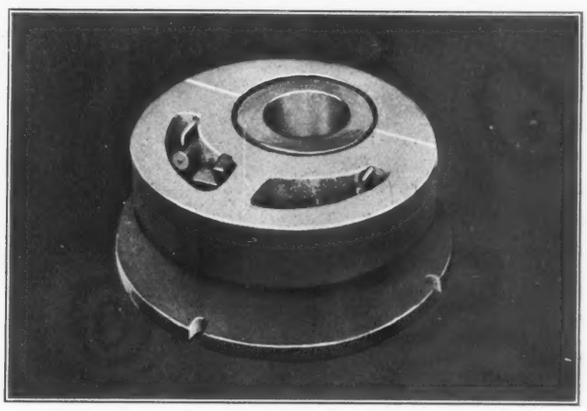


Fig. 23. Fixture for Holding Eccentrics on the Boring Mill while turning the Outside

the usual tool-post, and the tool is clamped in place by the long set-screw shown. The feeding mechanism of the rotary attachment, is too plainly shown to need explanation and this, together with the traveling shaper head, gives whatever motion is needed and by using suitably shaped tools the openings

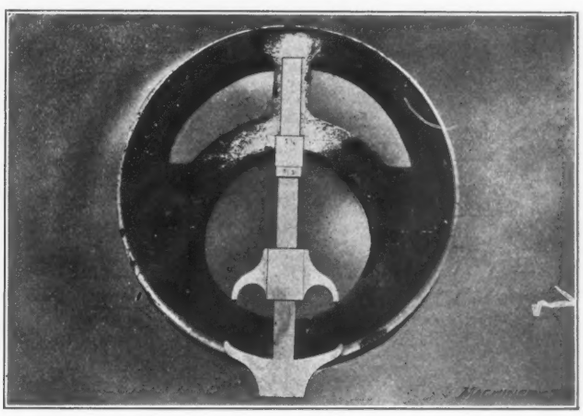


Fig. 24. Tool for Laying Out Eccentric Keyways

are cleaned out in good time without leaving the fillet which is the result of ordinary methods.

Turning, Boring and Cutting Packing Rings

Packing rings are bored and turned in a boring mill in the same way as cylinder bushings. They are then cut off with a gang tool, the cutters of which are so set that the top ring is cut off a little ahead of the one below it, as shown in Fig. 14.

Fig. 25. Rounding the Ends of an Eccentric-rod Jaw on a Vertical Miller

The method used to hold the packing ring casting to the table is rather unusual. Four "legs" are cast on the bottom of the casting and special jaws or "sockets," into which these legs fit, are used on the face-plate. These sockets are held by

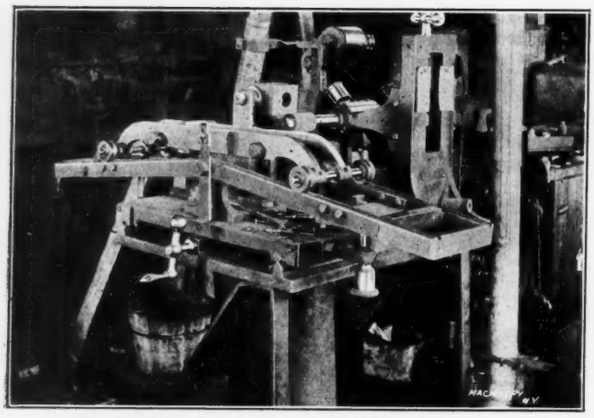


Fig. 26. Grinding Link-blocks on the Machine shown in Fig. 30

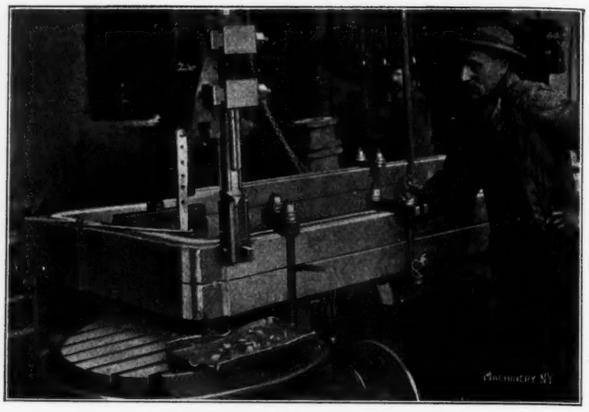


Fig. 27. Slotting Mud-rings

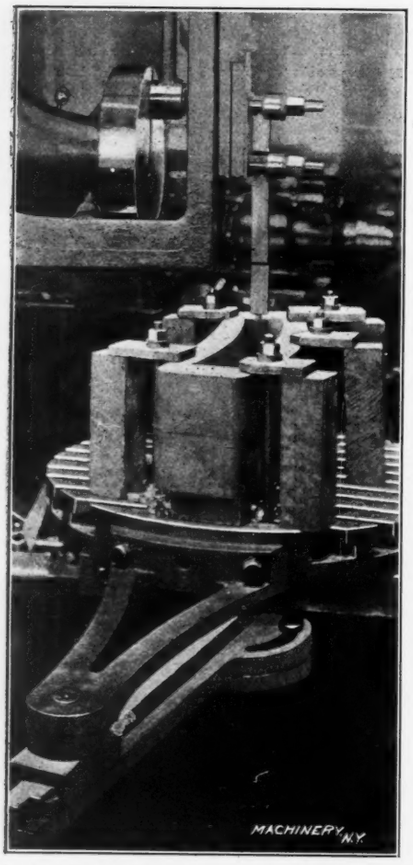


Fig. 28. Slotting Links by the use of an Attachment which gives the desired Radius

set-screws from the side and centered by set-screws from the inside. The plan of using legs on the casting, has many advantages over the usual flange or flaring lugs, as it is utterly impossible for the casting to twist, and only a minute or so is needed to center and clamp it solidly in place, with no tendency to spring it out of round. After being cut off, the rings are milled for a lap joint, and then finished two at a time, in the jig shown in Fig. 15.

Driving Boxes

Driving-boxes are machined out inside for the brasses one at a time, on a slotter using a single cutting tool and a rotary table

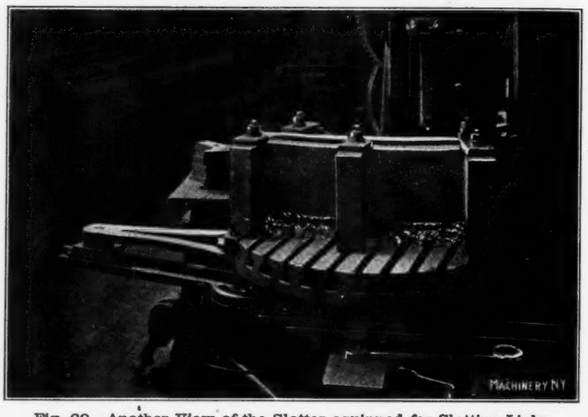


Fig. 29. Another View of the Slotter equipped for Slotting Links

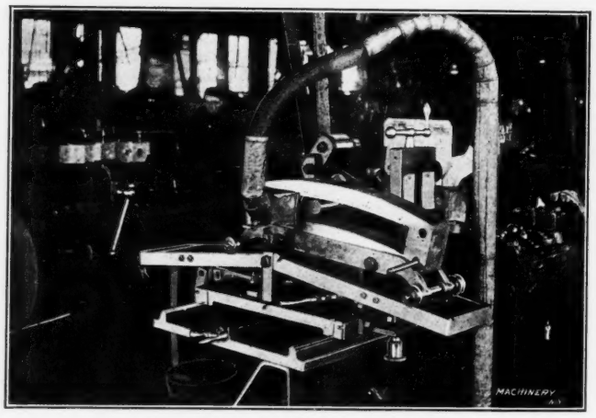


Fig. 30. Grinding the Links on a Special Grinder

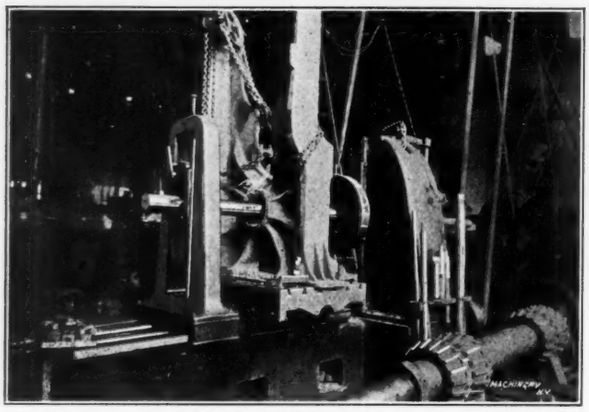


Fig. 31. Boring the King-pin Hole in the Front Deck Casting

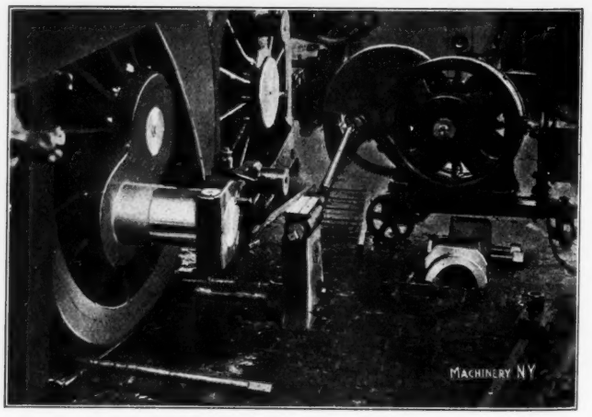


Fig. 32. Valve-setting Machine, which is driven by an Electric Motor

feed as shown in Fig. 17, and the brasses are held in a fixture on a boring mill (Fig. 18) while the outside is turned. The straight edges are then surfaced off, the brass forced into the box and the inside bored out, the end turned and the inside edge rounded, as shown in Fig. 19.

In order to reach the sides of the driving-box between the

flanges, extension chuck jaws have been made that fit over the top of the regular jaws of the boring mill.

Fig. 16 shows the fixture used to hold the truck cellars while machining the sides in a shaper.

Boring Side-rods

Side-rods have a hole drilled in each end, where the center of the bearing is to be, for the pilots of the cutter-heads shown in Fig. 20. The bulk of the metal is cut out in round blocks, and the holes finished with single-cutter boring tools

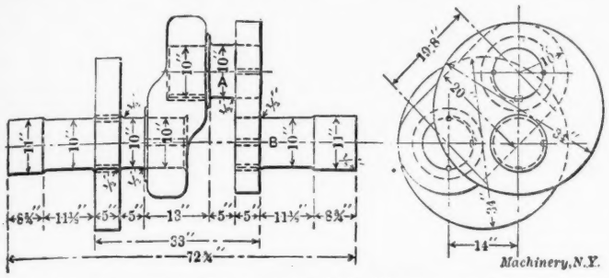


Fig. 33. Crank-axle, the Pins of which are turned by the Tool shown in Fig. 34

in a two-spindle drill press as in Fig. 21. Driving rods have a row of holes drilled across the end of the intended fork, and the metal is then roughed out in two cuts on a Higley cold saw as in Fig. 22.

Eccentrics and Eccentric Rods

A fixture for holding eccentrics on a boring mill while turning the outside is shown in Fig. 23, and in Fig. 24 is a tool made expressly for laying out the keyways in eccentrics. This tool is made for laying off either 1⅛ or 1¼ inch keyways by simply reversing the small slide on the bar. A shoulder on the under side of the slide, allows it to be placed just right for the depth of the keyway wanted. By using this tool the keyways are laid off absolutely straight and directly in line with the thickest part of the eccentric. The ends of eccentric-rod jaws are rounded on a Bement-Miles vertical mill with rotary table feed, as shown in Fig. 25.

Machining Link Slots

Some of the most interesting operations of the shop are those through which the links are put while the arc-like slot is being machined, as the machines and attachments are unusual. The slot in the link is roughed out to the proper radius on a Sellers slotter, using the cross-slide feed of the table and a special attachment shown in Figs. 28 and 29. This attachment consists of an arm solidly bolted to the circular table, to the end of which is fastened a pivoted slide running on a guide which is bolted to the knee of the slotter. The guide is so made as to be easily adjusted, to a limited extent, to different angles with the cross-slide ways, and in this way the work is caused to describe a different arc past the cutting tool if desired. While the cross feed is in use, the circular table is, of course, left unlocked and free to revolve on its center as far as the attachment will turn it during the cutting operation.

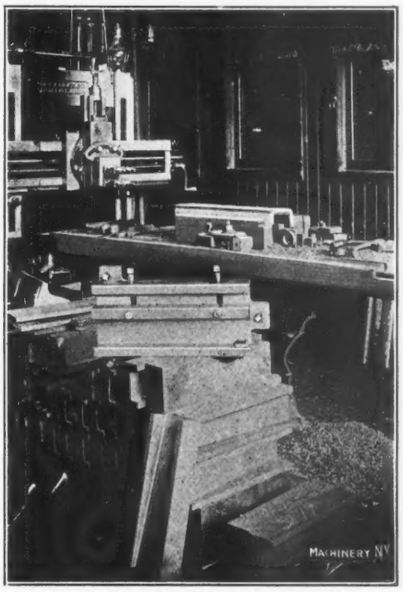


Fig. 37. Special Chuck used for Planing Shoes and Wedges

Two link-slots are roughed out at once on the slotter, after which the links are placed one at a time on a special grinder, Fig. 30, and finished inside. The carrier of this grinder, to which the link is clamped, is a small four-wheeled truck running upon a double-inclined track, one incline of which is adjustable up or down to change the arc of travel described by the link. The whole attachment of track and carrier is mounted on the grinder table so that it can be fed to or from the wheel by turning the ball-crank on the feed screw. The grinding wheel has vertical adjustment, and an air pipe keeps the work free from dust and metal as the link is pushed back and forth by hand.

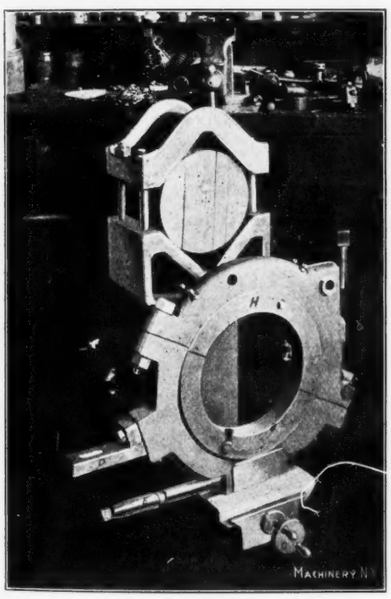


Fig. 34. Tool for Turning Inside Crank-axle Bearings

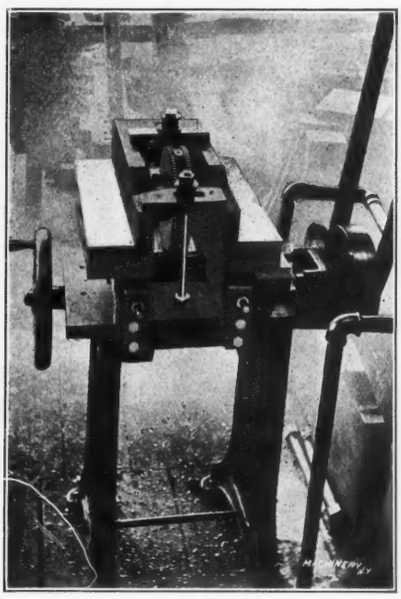


Fig. 35. Machine in which the Crosshead Pins are turned

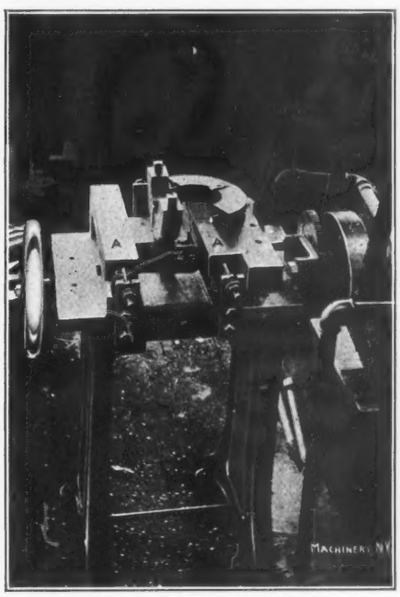


Fig. 36. View showing the Mechanism of the Crosshead Pin Turning Machine

Fig. 26 shows the same machine arranged for grinding a link block to the proper curve. By fastening the block to an auxiliary bracket which is attached to the link carriage, as shown, both the top and bottom can be ground at one setting so as to exactly fit the slot.

The method of machining mud-rings two at a time on a slotter, is shown in Fig. 27. Fig. 31 shows the hole in the front deck over the pony truck being bored out. The form of shoe and wedge chucks used to hold the shoes or wedges when planing them on a small Gray planer is shown in Fig. 37. The set-screws in the lugs on the end of the chuck in the fore-ground, plainly show how the chuck is tilted to get the right bevel on the wedge.

Novel Tool for Turning an Inside Crank-axle Bearing

A rather unique fixture used to turn the crank axle bearing (*A*, Fig. 33) is shown in Fig. 34. The crank-axle is held between centers in a lathe for convenience in handling and the fixture is clamped onto it, the bearing *B* of the crank-axle being where the wooden block is shown in the engraving, the ring *H*, carrying the cutting tool, being around the part *A*. The part *D* is placed on top of the tool carriage of the lathe to steady the fixture and keep it from turning. An electric motor is coupled to the shaft *E*, the inner end of which is a worm, meshing with teeth cut in ring *H*. The tool is fed along the cut by the hand wheel *G*. Formerly an air motor was used to drive the cutting mechanism, but it was found to run too jerkily to cut right so an electric motor was substituted with good results.

Turning Crosshead Pins

Crosshead pins are turned in the machine shown in Fig. 35, the parts of which are shown in Fig. 36. This tool is somewhat similar in principle to the one just described in Fig. 34, but a pinion and gear teeth are used to drive the cutter instead of a worm and worm gear, hand feed being used in both cases. The crosshead is adjusted for height on the machine, by means of the wedges *A-A*.

The usual locomotive valve-setting device has been supplemented in these shops by a Westinghouse 7½ H. P. reversible electric motor, mounted on a hand truck and made to drive the rollers which turn the locomotive wheels, by means of gears and a universal jointed shaft, as shown in Fig. 32.

* * *

BEARING METALS*

JOSEPH H. HART†

By conservative estimate the value of the bearing metal in actual use in the United States exceeds $50,000,000, of which fully one-half is used on the locomotives and rolling stock of the railroads of this country. In view of the increase in the amount of machinery and rolling stock steadily going on, and the constant wearing out and replacement of bearings, the value and importance of this product cannot be over-estimated. The life of a machine is largely dependent upon its bearings, and in view of this, the fact that knowledge in regard to bearing metals and alloys is not more general, is remarkable. Again, the nature of the production of these alloys is such that while in some cases they have been patented and are manufactured under trade names, in many others they are made up of scrap, with widely varying proportions of the different metals incorporated in their structure; on this account, probably no phase of engineering progress in machinery construction and operation is the subject of more difficulty and dissatisfaction.

The fact that bearing metals have to be taken largely on faith or else tested by more or less complicated processes for their chemical constituents, and the further fact that trade conditions in this field are such that the properties of metals are apt to vary greatly in different shipments is a matter of grave import to the average machinery manufacturer and operator. Only the largest consumers can afford to make the necessary tests and investigations of a given consignment in order to test its quality, and, in addition, a definite amount of special knowledge is requisite for this purpose, in view of the often wide variations in properties of the alloy, with a comparatively small variation in the proportion of its constituents. Under these circumstances the average small machine shop and consumer in this field accepts bearings on faith alone and is dependent largely upon the commercial reputation of the firm furnishing the material. That this should not be so is a foregone conclusion, but in view of this condition of affairs the rapid progress of the firm whose standing can be relied upon in this field is readily explained.

Bearings are usually composed of alloys of copper, lead, tin, antimony and zinc, and are known as babbitt metal (after the name of the discoverer of this material), white metal, brass, phosphorous bronze, and various other trade names. Quite a number of these are patented, such as "plastic bronze," etc., but many are sold merely under trade name, and in some instances are of uncertain composition.

The principal qualities which a good bearing metal should have are good anti-frictional properties, so as to withstand heavy loads at high speed, without heating, and second, sufficient compressive strength so as to neither be squeezed out of place under high pressure, nor crack or break when subjected to sudden shocks. In addition to these, many other properties must be considered in a choice of bearing metals depending upon the special purpose for which the material is to be utilized. Temperature variation is often an important factor, especially in refrigerating plants, and the coefficient of expansion should be considered to prevent undue binding, with consequent destruction of the bearing and the possible variation in other properties, such as brittleness, ductility, etc., under various temperature conditions. In addition, many bearings must operate under conditions where they are subject to chemical action, whether that of brine or ammonia in refrigerating plants, or acids, alkalies, etc., in chemical establishments, and in dynamo and motor construction and operation, the electrical conductivity must be considered as well. This statement applies equally to all bearings incorporated in electrical machinery, where these must serve as electrical conductors such as the bearings for the wheels in trolley cars, etc.

The chief properties to date which have been developed to a greater extent than others in machine design are, that of friction elimination and resistance to compressive loads. Theoretically all metals have the same friction, according to Thurston, and the value of the soft white alloys for bearings lies chiefly in their ready reduction to a smooth surface after any local impairment of the surface, such as would result from the introduction of foreign metal between the moving surface and the bearing. Under these circumstances the soft alloys flow or squeeze from the pressure into the irregularity, forming a larger area for the distribution of the pressure, thus diminishing its amount per unit of area. Further, the larger area over which the pressure is extended the less becomes the liability to over-heating and consequent binding. Under these circumstances the frictional properties of a bearing are in inverse ratio to their compressive resistance, and invariably the best bearing alloys, from a high speed viewpoint, are unsatisfactory for utilization in heavy machinery. The recent introduction of an iron or steel grid to form the base of the main bearing, and to be filled with much softer bearing metals than could ordinarily be installed, or in some cases even graphite, is a step in the right direction and presents possibilities of great importance in this field of machine development.

Lead flows more easily than any of the common metals under pressure, and hence it has the greatest anti-frictional properties. Of course, a number of metals exceed lead in this property, but their cost or some other factor render them unavailable. Lead is the cheapest of the metals, except iron, and in comparison to the other metals used in the formation of bearing alloys their relative prices are somewhat in the following order per one hundred pounds: Lead, $4; zinc, $5; antimony, $9; copper, $13; and tin, $30 or more. It can thus be seen that the more lead that is used in a given bearing, the softer it is, the less friction it possesses, and the cheaper it can be furnished. It is, however, too soft to be used alone, as it cannot be retained in the recesses of the bearing even when used simply as a liner and run into a shell of brass, bronze or gun-metal or some other alloy. Various other metals have been alloyed with it, such as tin, antimony, copper, zinc, iron and a number of non-metallic compounds, such as sodium, phosphorus, carbon, etc., and the effect of the different ingredients is to-day fairly well understood.

If antimony is added to the lead it increases its hardness and brittleness, and if tin is added as well it makes a tougher alloy than lead or antimony alone. Nearly all of the various babbitt metals on the market are alloys of lead, tin and antimony in various proportions, with or without other ingre-

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: The Study of Alloys Suitable for Bearing Purposes, October, 1903, engineering edition; Oil Grooves and Bearings, May, 1905; The Design of Bearings, December, 1906, January and February, 1907, engineering edition; Hot Bearings, Their Causes and the Means of Avoiding Them, November, 1907. See also MACHINERY'S Reference Series No. 11, *Bearings*.

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dients added. In such babbitts, the wear increases with the antimony as a general thing, and the price with the tin. The higher antimony babbitts are used in heavy machinery, as they are harder, while those low in antimony are used in high speed machinery. The steady increase in speed at which various operating units are maintained is responsible for a wide deficiency in this field in the duty performed by the bearing metal. The chief difficulty to-day in the operation of the modern turbine is undoubtedly the maintenance of satisfactory bearing surfaces. Soft babbitts have never sufficient strength to sustain the weight and shock of heavy machinery bearings and can only be used as liners. The tendency to increase in speed as well as weight or size of machinery is limited to-day simply by the satisfactory operation of the bearing metal itself.

Undoubtedly, in investigations in this field, sufficient attention has not been paid to the effect of temperature on the bearing properties of the alloys used for these bearings. More rigid investigation in this field and limitations in regard to the temperatures permissible, with means for maintaining

COMPOSITION OF BEARING METALS.

Alloys.	Lead.	Tin.	Antimony.	Copper.	Zinc.	Other Constituents.
Babbitt 1	80.00	20.0	.....	.....	.....	.....
Babbitt 2	72.0	21.0	7.0	.....	.....	.....
Babbitt 3	70.0	10.0	20.0	.....	.....	.....
Babbitt 4	80.5	11.5	7.5	0.5	....	.....
Babbitt 5	0.5	68.0	.....	1.0	31.5	.....
Babbitt 6	.....	20.0	.....	.....	80.0	.....
Babbitt 7	.....	86.0	10.0	4.0	.....	.....
White metal	82.0	.....	12.0	6.0	.....	.....
White Brass	....	64 0	.....	2.00	34.0	.....
Magnolia metal	80.00	4.75	15.0	trace		$Bi = 0.25$
Car brass lining	80.5	11.5	7.5	0.5	.....	.....
Ajax plastic bronze	30.0	5.0	.....	65.0	.....	.....
Ajax metal	11.5	11.5	.....	77.0	.....	.....
P. R. R. car brass, B	15.0	8.0	.....	77.0	.....	$P = 0.80$
S bearing metal	9 5	10.0	....	79.7	.....	.....
Delta metal	5.1	2.4	.....	92.4	.....	$Fe = 0.1$
Camelia metal	14.8	4.3	.....	70.2	10.2	$Fe = 0.5$
Tempered lead	98.5	0.08	.....	0.11	.....	$Na = 1.30$

Bi = bismuth; P = phosphorus; Fe = iron; Na = sodium.

these within fairly close limits, will undoubtedly result in a great increase in the possibility of improvements in speed and weight of various types of machinery. More or less extensive experiments along these lines are being conducted in regard to the bearings used in turbine construction, since the speed here has rendered the problem an acute one and is necessary for efficient operation of the turbine itself.

The accompanying table will doubtless prove interesting as showing the various constituents of the more or less common bearing metals now on the market. The original babbitt-metals were very expensive materials, on account of the proportions of the more expensive metals found in them, and have been much modified in actual practice. A wide deviation in the composition of babbitt is readily shown in the first part of the table. The first babbitt is a fairly good alloy for high speed machinery but is not very hard. Its melting point is about 500 degrees F.; in fact, the properties of all alloys or bearing metals can be very widely deduced from their melting point. The second babbitt is somewhat harder and melts at a higher point. Both of these are used largely for lining purposes. The fourth babbitt is used very widely for heavy machinery. All of the babbitts mentioned have been fairly successful.

Babbitt 6 has good wearing properties but cannot be used for high speeds. Most of the other metals included in the table where copper is not used in excess can be regarded as in the same class as babbitts. The "white" class has a fairly good electrical conductivity, much greater than that of ordinary babbitt, and is used in the bearings of generators, motors, electric cars, etc. A rather interesting thing about the alloys containing sodium is based upon the fact that sodium by oxidation produces a material which will saponify with the oil used in the bearing and produce soap, thus assisting lubrication. The extent and amount of such action is scarcely as yet understood, and practically no experiments have been made with this investigation in view. Possibilities along this line, however, are great, not only for this particular alloy but for many others not as yet considered.

The other alloys included in the table consist to a very great extent of copper, tin, and lead, and usually have a thin liner of lead or some soft babbitt, and hence wear much better than an entire bearing of the soft babbitt. The tendency to wear decreases with increase of lead and increase of tin. Increase of lead, of course, diminishes the frictional effect of the alloy and hence its heating properties. A certain amount of other metal, however, is necessary to keep the lead from separating from the copper. A study of the table itself, with a knowledge of the various properties of the metals themselves, will show conclusively the bearing properties of the different alloys. Pure copper is so tenacious that it is practically impossible to work it with any tools whatever without preliminary treatment and this same property extends into and influences its bearing properties.

The structure and treatment has more to do with the production of suitable bearing alloy than is generally considered. The tensile strength of solder and, in fact, all alloys, decreases very greatly with the pressure or tension at the time of solidification and in general the cooling process, and the influence on tempering affect the structure and consequently compressional resistance to a much greater extent than is generally considered. The same properties which influence the hardening and tempering of steel by heat, extend to a greater or less degree to all metals and are much more pronounced in alloys than in the simple elements.

Sufficient has been said to show the importance of the bearing metals in machine design to-day, and to give a brief outline of the situation in regard to the character and type of the metals available, with a few of the properties of the same. The possible combinations of alloys for this purpose are very great. Comparatively little progress has been made along investigations covering all possible alloys of different materials in different proportions. The recent introduction and placing on the market of a large number of metals, such as calcium, etc., very common in nature, and ultimately bound to be furnished at a very low rate, and many of them possessing very suitable properties for bearing alloys, is undoubtedly bound to influence the situation; and various engineering devices, such as the steel grid, recently developed, will undoubtedly receive attention in the immediate future with consequent increase in efficiency in this field. The development is but at its inception along this line, and standardization of the alloys at hand should be at once insisted upon and maintained by the various machine manufacturers. This latter is the chief difficulty to-day in commercial development. The scientific end will largely take care of itself. The effect of different metals upon alloys by their presence in various proportions can be foretold to-day largely from theoretical considerations; but that the commercial situation to-day, however, is unsatisfactory, is a foregone conclusion.

* * *

A British firm has recently completed what is believed to be the largest crane in the world. The total height of the crane is 166 feet; it is of the revolving cantilever type and will lift 160 tons at a 95-foot radius. The crane is driven by five large electric motors, the machinery being placed on the rear end of the cantilever and thus acting as a counter-balance of the load. At the tests the crane showed itself capable of lifting and moving loads up to 240 tons. The crane itself weighs about 950 tons.

* * *

A company which is to purchase the exclusive rights for the Wright aeroplane for the German Empire and its colonies, as well as for Sweden, Norway, Denmark and Turkey has been formed at Berlin with a capital of $125,000. The arrangement with the Wright brothers will extend over a period of fifteen years, during which time the company is to be entitled to all improvements made by the inventors during this time. The Wright brothers have also made arrangements with the Italian government, and in England they are building a number of machines for private sale. It is stated that not less than forty Wright aeroplanes are at the present time under construction in France.

INFLUENCE OF THE SCLEROSCOPE IN METALLURGY AND MANUFACTURING*

A. F. SHORE†

The scleroscope is an instrument in a measure dependent on sensitive touch; or, in other words, it feels the substance much the same as the human fingers. When we touch two or more objects as, for instance, an orange and an apple, we know that the orange is softer because it yields under pressure more than the apple. We are powerless to measure the hardness of any object that is harder than the finger tips, and there is no way of telling how hard it may be by finger pressure alone.

The sensitive touch of the scleroscope is produced by a tiny hammer dropping from a height of about ten inches onto the metal, hardened steel, etc., which it penetrates slightly. The hammer moves freely, yet snugly, within a glass tube and weighs about 40 grains. Its striking point consists of an inserted diamond of rare cleavage formation, annealed sufficiently to withstand shocks. This jeweled point is slightly convex and has an area of about 0.001 to 0.025 square inch. When the plunger strikes the metal to be tested, it reacts or rebounds. The height of this rebound is read against a graduated scale, and an accurate determination of the quantitative hardness of the piece under test is thus obtained.

The static testing of soft metal, using a steel ball which is forced into it with a known pressure so as to cause an indentation which can be measured with the microscope, is on a par with the testing of a peach or apple with the unaided nerve cells of the fingers; it fails in dealing with hardened steel, as it is like touching brass and steel to determine the difference in hardness. We could detect no yielding tendencies in either, and they would, therefore, seem to be of equal hardness. By tapping the two with the ball end of a hammer, however, we could tell which of the two is the harder, in that one would yield more and thus absorb more of the energy of the hammer blows; in other words, the harder the metal, the less yield, the less work done, and the higher the rebound of the hammer. On this principle the scleroscope is based. Some have said, for this reason, that the instrument is really a measure of elasticity. This, however, is not true. The elasticity of the metal or material is utilized as a motive force to work the sensitive indicator as will be demonstrated in the following.

Hardness vs. Elasticity

When the hammer of the scleroscope is allowed to drop with no other force than its own weight, and the point is so flat that absolutely no impression is made on the surface of very hard steel, then the rebound will be about 90 per cent of the fall. This phenomenon is known as the elasticity of solid bodies. Now, since hardness is resistance to penetration, in its clearest definition, it stands to reason that the point of the hammer must be somewhat reduced and rounded. Therefore the relation between the weight of the hammer and its point should be such that when it drops on hardened steel, a permanent impression must always be made, so that if we had not the rebound to go by, the microscope would still show the values. What is the result now? When the area of the hammer is thus reduced enough to make a permanent impression, a certain amount of the energy stored in the hammer is utilized in doing work. This overcomes the tendency of the metal to resist penetration, depending on how hard it is, or the resistance it offers, and naturally it must rebound considerably less. The hammer always delivers a blow of exactly the same force. If now we get a rebound of 75 per cent on very hard steel, we know that 15 per cent of the hammer's energy was spent in its efforts to overcome the resistance of the steel before it had a chance to react and repel the missile.

The Instrument

Instead of dividing the whole length of the fall of the indicator into a scale consisting of 100 divisions, the figure 100 is carried down to a point representing about 68 per cent of the total height of the scale as shown in Fig. 1. This was not an arbitrary provision, but was adopted after consultation with the leading metallurgists, one of whom was Dr. Paul Herault, of aluminum and electric steel making fame, of France. These authorities agreed that in the scleroscope, hardened steel of average hardness should be taken as the standard with which all other less hard metals should be compared: 100 is the average hardness of hardened steel; 90 is a low value, while 110 is a very high value. This scale

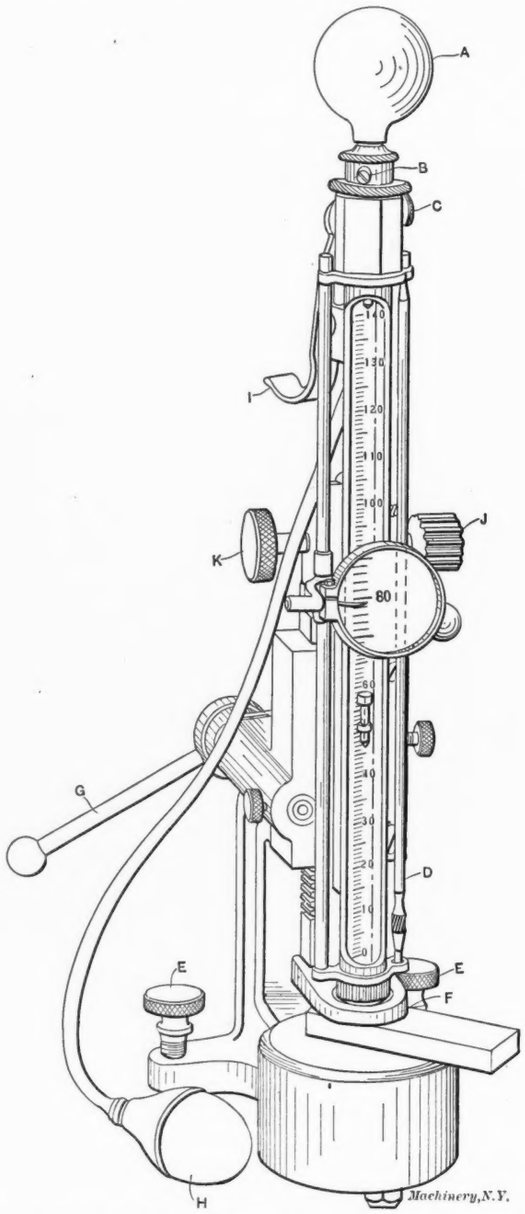

Fig. 1. Detail View of the Scleroscope—an Instrument for Testing the Hardness of Metals

therefore makes it an easy matter to compare the various metals which have to be cut or worked with steel, as we shall see further on.

The operation of the instrument is very simple. When the hammer is to be raised to the top, the bulb *A*, Fig. 1, is pressed and then released suddenly. This sucks up the jeweled plunger hammer referred to, so that it may be caught by a hook which is suspended exactly central in the glass tube and engages with an internal groove on the top of the hammer. Adjusting screws *B* for the hook and its spring are contained in the removable knurled cap. *C* is a cylinder and piston for releasing the hook and hammer by bulb *H*, whenever a test is to be made. *I* is a valve and hook which is pressed and thus opened at the same time to avoid a vacuum when the hammer drops. *J* is a pinion knob for moving the instrument up and down independently of the heavy rack and clamp *F* actuated by the lever *G*. At *E* are shown leveling screws and at *D*

* For additional information on the testing of metals, see "The Brinell Method of Testing the Hardness of Metals" (engineering edition), September, 1908, and "A New Mechanical Test for Hardness" (engineering edition), October, 1908.

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a plumb rod. When flats and sheets and small pieces are to be tested, the scleroscope, self-contained with its clamp and anvil, is employed. When the ends of drills, rods and many other tools are to be tested, they are clamped in a bench vise, as in Fig. 2, and a swinging arm is employed. In this case, the instrument is removed from its post on the clamp frame by knurled set-screw *K*, and is attached in the same way to the post on the swinging arm. A kind of female dove-tailed finger ring, adapted to be clamped on the dove-tailed rack bar of the instrument, is provided for use in free-hand testing and very large floor work, on parts of machinery being assembled, or on the stock rack, etc. It will thus be seen that the apparatus is universal in its application.

Philosophy of the New Method

When the hammer falls through a height of ten inches onto hardened steel, it will deliver a striking energy equal to about 20,000 times its own weight, acting through a very short space, of course. With a hammer weighing about 40 grains, and an indentation of, say, 0.002 inch depth, a working pressure of about 100 pounds is obtained. This force acting on a convex point about 1/64 inch diameter, is concentrated. The pressure thus available is about 500,000 pounds per square inch, which is ample to exceed the elastic limit of the hardest and strongest steel in existence.

A remarkable feature of this instrument is that it is self-compensating with regard to the energy of the hammer blows on the softer metals. This is due to the yielding of the material and the comparatively slow stoppage of the hammer. In lead, for example, a deep impression is made. This requires a great amount of energy, which is nearly all spent in doing work, and there is very little rebound afterward—about 3 degrees as against 110 for the hardest steel. The constant pressure developed by the hammer is thus only 12 pounds instead of 100 or more for good hard steel, and, of course, the pressures for intermediate hardnesses as on brass and soft or tempered steel are always in proportion to the physical hardness of the brass or steel.

Application to Shop Work

The manufacturer who wishes to get high efficiencies out of his tools will not benefit by the help of such a commodity as the scleroscope in detecting good and bad tools, unless he is willing to amend the errors in practice which he may find. The observation of this principle is the foundation of the success which hundreds of firms in this country and Europe are having with this instrument. While tool work is a line requiring the most careful attention, the material worked and produced is none the less important. In this connection the scleroscope is very commonly applied to industrial systems, with admirable results. An instance may thus be cited showing how these results are obtained.

More than a year ago the Brown & Sharpe Mfg. Co. adopted the new method as a guide in the laboratory, particularly for the study and selection of such fine steel as is required in standard commercial tools. The attention of the company was then turned to its high-grade automobile gears of alloy steels, etc. Meanwhile the Packard Motor Car Co. used the scleroscope to study the past performances of the various gears and parts of old Packard cars, and made careful records. This was also done by many other concerns, and these records showed that alloys, steel or nonferrous metals would give a certain efficiency if the hardness was just right. As the best is, in the end, the cheapest, in high-grade apparatus, the Packard engineers began to issue orders to their various auto part making houses for material which was specified to require a given degree of scleroscope hardness. Gears were made for them by the Brown & Sharpe Mfg. Co. and the Gleason Works, both of whom were using the scleroscope to aid them in filling orders. Wyman & Gordon, who supply forgings to Brown & Sharpe, were able to make them to the required specifications, but, in order to do so, they had to see that the raw material was of the proper hardness. This brings the matter back to the open-hearth or crucible and chemical laboratory, where again the scleroscope is used to great advantage. Before the completion of an automobile of the guaranteed kind, often a dozen instruments are used among the specialty makers who supply the various parts. The ball-bearing manufacturers are required and prefer to test every part before assembling. The Hyatt Roller Bearing Co. and the Hess-Bright Mfg. Co. are obliged to use a number of scleroscopes which are operated by women, carefully trained, who are able to pass on a large number of pieces daily. This testing is to ascertain principally two factors on which success in service depends, *viz.*: the right degree of hardness, and the uniformity of this hardness—and both are equally important. In the latter case it is necessary to test the parts in a number of places, which must be done very rapidly to keep down the additional costs, particularly as in the manufacture of standard parts such as these, there are always losses due to the rejection of some parts which do not conform to the specifications.

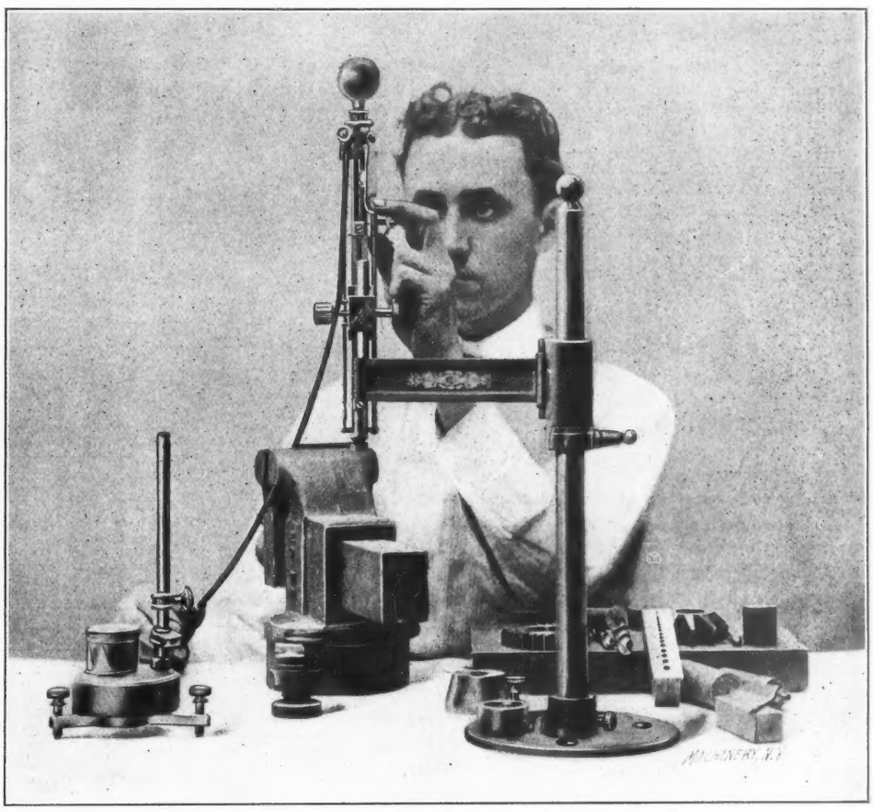

Fig. 2. Scleroscope equipped with Swinging Arm for Testing Pieces clamped in Bench Vise

The Lunkenheimer Co., the Light Mfg. & Foundry Co., and other up-to-date manufacturers, use the scleroscope in the standardization of castings adapted to various needs. These houses also make auto parts for the Packard Co., etc., and by the use of the scleroscope are enabled to live up to their specifications. In these auto shops the instrument is used for all classes of work, although it is most needed in the inspection department for the examination of parts and material, particularly of those not made by the builders.

Tool Steel and the Scleroscope

Since for most uses (other than for turning or planing tools) plain carbon steel is as yet adequate, many manufacturers have turned their attention to the art of obtaining much

higher efficiencies by aid of the scleroscope after good steel has been selected. The method of doing this is interesting, and was first hailed as a revelation by many authorities. Thus, when a steel having a carbon content of 0.90 of one per cent and over is heated to the right temperature and is then properly quenched, the limit of hardness and strength is obtained. Now, attaining this temperature is such a delicate matter, that unless the very best facilities are at command, anything but the exact heat required may be obtained, and if the heat is too low the tool will be hard only on the edges, while if it is

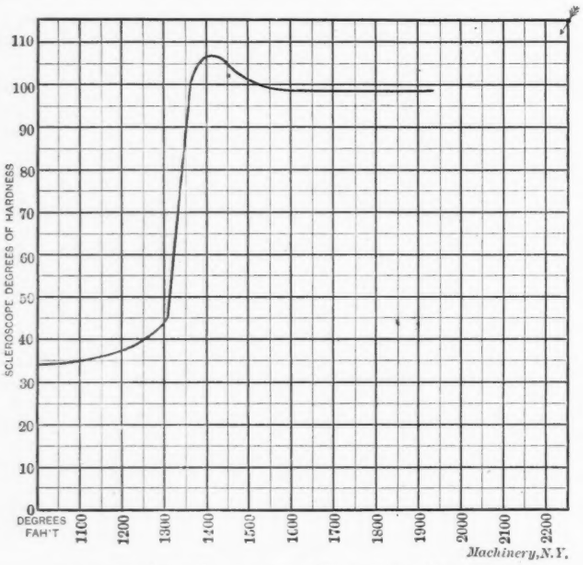

Fig. 3. Hardness Curve for Tool Steel of about 0.90 Carbon

only a trifle overheated such as is regularly done by the average hardener who takes chances by depending on skill of the eye, something like from 50 to 75 per cent of the strength due to rolling or forging is lost. This appalling loss in strength so vitally important in any tool is accompanied by a slight drop in the hardness—not more than 5 per cent. This is detected by the scleroscope as shown in charts, Figs. 3 and 4. The former is a hardness curve taken from a tool steel of about 0.90 carbon, while the latter is one taken from a steel having 1.65 per cent. The difference between these curves is indeed very striking and very significant to those who have mastered the elementary principles of the study of tool steels by aid of the scleroscope. The curves are obtained from the Metcalf test as follows: A piece of steel a few inches long and about one-half inch square is heated to a bright yellow on one end and manipulated so that the temperature is less and less toward the other end until a red is scarcely visible. The piece is then quenched in water, ground clean, and tested by the scleroscope at intervals of about ⅛ inch along the bar, beginning at the unhardened end. As each section is tested, a reading is obtained which corresponds with the exact hardness that would be obtained by quenching a similar piece at whatever heat the said test piece had in that location. This hardness number is plotted out on a chart in the usual way so that a true curve is obtained showing the character of the changes in hardness and strength which vary directly with the carbon content. In fact the most accurate analyses of this element are made in this way—but that is a subject by itself.

The test piece thus obtained represents a stock bar, of the steel which is to be worked into tools, dies, etc., hardened at temperatures that vary more widely than could occur in any well-regulated hardening room, and somewhere within these limits is the temperature that yields the maximum hardness. It supplies an expedient whereby the hardener may know exactly what temperature is most suitable for each tool made from the steel thus tested. His future work is guided and facilitated by stamping on each tool a number corresponding to the hardness number given to the said stock bar. It also enables the hardener or the inspector to intelligently test all hardened tools. Thus, if a die is hardened to 95, we can determine by referring to the test piece of steel, whether this is the highest degree of hardness obtainable with this steel. If the test piece showed the hardness to be, say, 100 or 110, and the die only showed 95, it would indicate that the die did not fulfill the necessary requirements.

SCLEROSCOPE HARDNESS SCALE

Name of Metal	Annealed	Hammered
Lead (cast)	2—5	3—7
Babbitt metal	4—9	
Gold	5	8½
Silver	6½	20—30
Brass (cast)	7—35	
Pure tin (cast)	8	
Brass (drawn)	10—15	24—5
Bismuth (cast)	9	
Platinum	10	17
Copper (cast)	6	14—20
Zinc (cast)	8	20
Iron, pure	18	25—30
Mild steel, 0.15 carbon	22	30—45
Nickel annode (cast)	31	55
Iron, gray (cast)	30—45	
Iron, gray (chilled)		50—90
Steel, tool, 1 carbon	30—35	40—50
Steel, tool, 1.65 carbon	35—40	
Vanadium steel	35—45	
Chrome—nickel	47	
Chrome—nickel (hardened)		60—95
Steel, high-speed (hardened)		70—105
Steel, carbon, tool (hardened)		90—110

NOTE.—These figures are subject to variations owing to nature of composition or compression of metals.

Advantage of Testing

It is noticeable in every shop that out of every lot of tools made there are always some "freaks"—tools that are jewels among others—although all are seemingly made alike. Some reamers will hold their size ten times longer than others; lathe tools, particularly thread and cutting-off tools, remain faithful to the setting through thick and thin and are usually kept in reserve for critical jobs. This may be because of defective steel, but usually the good and bad are made from the same bar, in which case we must look to our methods of hardening since the finest steel is most easily ruined, and is thus apt to make the poorest tools.

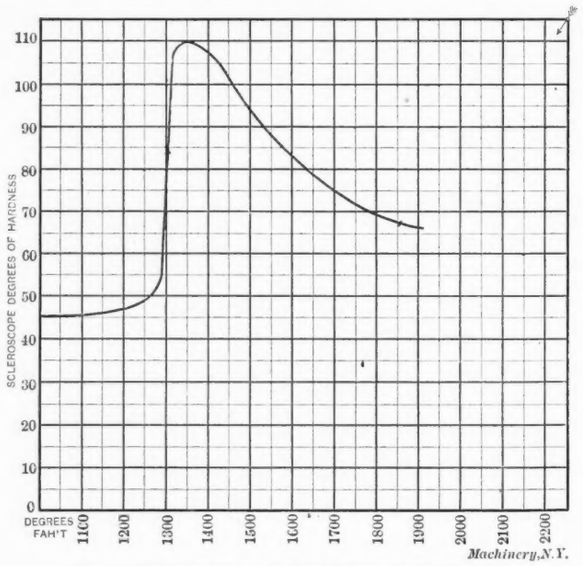

Fig. 4. Hardness Curve for Tool Steel of 1.65 Carbon

This latter fact has been known to steel makers for years, and because the abuse of tool steel is so general, none of the finest steels can be procured on the open market, but are made to order only. The explanation of this condition is simple. Tool steel is so sensitive to heat and water that only the photographic plate can be compared to it; it will produce a tool having 100 per cent efficiency only when treated just right. Like the novice in photography who occasionally gets a good picture if his lens is good, so is tool hardening a hit-and-miss process unless the workman be guided constantly. In this way workmen are enabled to acquire such precision of judgment that results seemingly incredible are obtained, and often testing instruments are used less constantly than one would think. Among many instances thus noted by the writer, one particularly interesting is the way in which the Winter Bros.

Co., Wrentham, Mass., who manufacture taps and dies, undertook to produce tools of the "jewel" variety as a regular product. Some of their taps were used on tough bronze in a turret lathe on a large scale, and often freaks were found which would never break until worn out. The most remarkable of these (7/16 inch diameter) held out three weeks at the rate of 10,000 holes per day as against only a few hours service for some taps. This tap was returned to the maker to be studied by aid of the scleroscope. The stock used was of tempered high-speed steel. The hardness remaining was measured although it was not known what the original hardness was nor exactly what temperature was used to draw it down to that hardness. The manager then ordered that 50 taps be made of high-speed steel and tested by the scleroscope. All these taps were hardened the same as the "freak" sample, and all were tempered with a heat which was variable (in fact it was unknown, except for the average) for the object in view was to get all pieces of the same hardness in the end, which was accomplished. The whole lot was next put to work and watched. After all had been worn out it developed that each tap proved to have the same efficiency as the freak. This resulted in the formal adoption of this method of hardening for taps of this steel and for the class of work mentioned, while other problems involving carbon steel were also gradually being solved along similar lines.

As a matter of fact, if only part of the new methods adopted since the first appearance of the scleroscope were described in detail, it would reveal something more than an incipient revolution, not only in metallurgy, but in most of the allied lines of industry and wherever tools are used and made.

The scleroscope is now regularly used to great advantage in naval construction, in the selection of materials for construction as castings and forgings, alloys, steel of all kinds and particularly in testing the hardness of projectiles and armor plate. All the United States government arsenals are thus equipped as well as those of foreign governments, including Japan. Likewise numerous mints and engraving bureaus are guided in their work, in which great economy must be practiced. Similar instruments are also to be found at the Bureau of Standards of Weights and Measures, and the leading railroads are using the scleroscope in their laboratories in the study of newer and superior rails, and rolling stock materials. In the steel mills a new departure has been made in that carbon content and other determinations can be made before the molten metal is poured from the hearth into the ladles, by means of a new dynamic method made possible by the scleroscope. This method allows the metallurgist the chance of making corrections before it is too late, which is of great importance. In the manufacture of non-ferrous metals such as brass sheet, rods, wire, etc., much can be told, by measuring the billets after casting, as to what will happen to the rolled or drawn products as well as what must be added or subtracted from the melts. The scleroscope also works very well on carbon, which fact was first demonstrated by the General Electric Co. All American carbon manufacturers now use it, and every dynamo or motor brush made of this material is first tested as to its suitability for the special work for which it is intended. Applied to glass, etc., it shows at once whether or not these materials are too brittle to be good. Wood rubber and other fibrous materials can only be tested by an especially sharpened drop hammer.

HIGH SPEEDS

TOUCHING ON THE EXTERIOR BALLISTICS OF THE MODERN HIGH-POWERED RIFLE

J. W., JR.

Probably the highest speed of rotation familiar to the layman is that of the later automobile engines which turn 3,000 R. P. M. more or less, while that which is best known to the engineer is the 30,000 R. P. M. which the rotor of the smaller De Laval steam turbine acquires. These speeds are high enough to present extraordinary difficulties to the designer but fast as they are they are quite outclassed by an object familiar to us all to a greater or less extent, the ordinary rifle bullet.

While the enormous number of revolutions per minute which one of the higher velocity bullets makes is not appreciated, yet every huntsman or target shot knows that it must acquire a rotation around its geometrical axis on account of the twist of the lands of the rifling in the barrel. The terrific speeds attained with some of the latest military ammunition are realized only by the ballistic expert, but play a very important part in the design and balancing of the bullets for the finer target ammunition.

Of the smaller calibers the best known and most popular all-round cartridge is probably the 0.22 "long rifle," the bullet of which is made of lead and weighs 40 grains. Its velocity as it leaves the muzzle of the gun is approximately 1,000 feet per second or a little over 11 miles a minute, quite a fair speed even in this day of fast automobiles and high-speed trains. The lands of the rifling have a twist of one turn in 18 inches, imparting to the bullet a rotative speed of 660 revolutions per second, or 39,600 R. P. M., which is "going some" but still quite within our conception. On account of its light weight, however, the 0.22 caliber bullet strikes a blow of less than 100 foot-pounds, enough nevertheless to put the ordinary squirrel or woodchuck out of business.

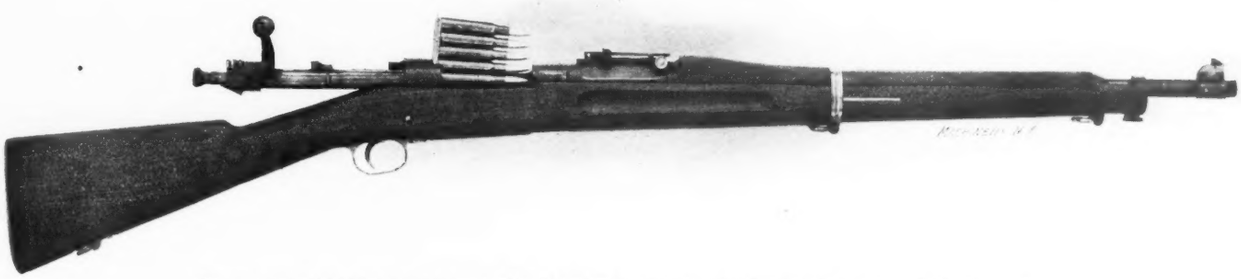

Fig. 1. Springfield Model 1903 Army Rifle, Latest Pattern, with Cartridge Clip in Place ready for Loading

The most talked of and deservingly most popular of the higher power sporting rifles for use with smokeless powders is the 0.30-30 Winchester, Marlin or Savage. The cartridge for this gun is loaded with a metal-cased or soft-point bullet weighing 165 grains, which upon being fired attains a muzzle velocity of 2,020 feet per second, or 23 miles a minute, and strikes a blow of 1,480 foot-pounds. After all it is not so wonderful that this little missile carries a message of death with every shot. The twist in a 0.30-30 barrel is generally about one turn in 12 inches, which imparts to the bullet a rotative speed of 2,020 revolutions per second, or 121,200 R. P. M. From this it appears that the steam turbine "is not in it" for speed, although it may be doing far more for the industrial development of society.

The most interesting problems for mechanical analysis, however, are presented by the new rifles and cartridges recently adopted by the United States Government. The new 0.30 caliber Springfield ammunition is the first to be scientifically developed, using a pointed or Spitzer bullet. This new bullet is slightly over an inch long, tapered like the end of a cigar to a point 0.050 inch diameter and weighs only 150 grains, by far the lightest bullet ever used for a military arm with the exception of the 6 mm. (0.236 inch) U. S. Navy Model which was soon discarded. The idea of using such a light bullet is to

produce an exceedingly high muzzle velocity with the same or only slightly increased pressure in the rifle chamber. The result of this high velocity is that the bullet travels in a trajectory which is very flat, requiring far less accurate estimates of target distances and so producing a much more efficient and deadly weapon in the hands of the inexperienced marksman.

The velocity of the bullet as it leaves the muzzle of the rifle is 2,700 feet per second, or over 30 miles a minute, which gives it a tremendous shocking power, striking a blow of 2,500 foot-pounds, enough apparently to put a whole regiment out of commission. The great linear velocity of this bullet produces an unexpected effect when fired from a rifle equipped with one of the new Maxim silencers. There is no doubt that this silencer destroys practically all of the noise caused by the sudden escape of the expanding powder gases, yet a shot fired under these conditions can be heard, under normal circumstances, for nearly a mile away from the firing point. This noise is undoubtedly caused by the rapid passage of the bullet through the air, which is separated so quickly that it returns with a crack or crash, producing an effect very similar to that caused by lightning.

While not only attaining such remarkable linear velocity this little high-speed projectile also rotates on its own axis at the rate of 194,400 R. P. M., the twist in the rifle lands being one turn in 10 inches. We have nothing to serve as an example for comparison with this speed and can only partially comprehend it when we realize that the periphery of this small nickel cylinder has a linear velocity of 3 miles a minute, or three times as fast as we consider it safe to run the best of cast iron fly-wheels.

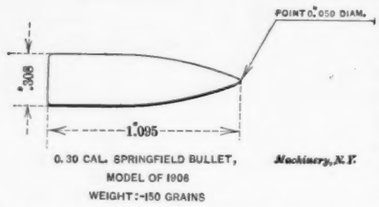

Fig. 2. Dimensions and Shape of Spitzer 150-grain Bullet

The amount of energy which this bullet possesses is much out of proportion to its size, and consists of the sum of that due to its rotation and that due to its linear velocity. To get at the amount of rotative energy involved, suppose we consider the bullet is made up of a cylinder 0.308 inch diameter, 0.595 inch long and a cone 0.308 inch diameter at the base with an altitude of 0.500 inch, the cylinder weighing 113 grains and the cone 37 grains. If M_1 is the mass of the cylinder; M_2 the mass of the cone; r the radius of the cylinder and the base of the cone; n the revolutions per unit of time; g (32.16) acceleration due to gravity; and I_p the moment of inertia around the geometrical axis of the bullet (polar moment), then

$$I_p = \tfrac{1}{2} M_1 r^2 + 0.3 M_2 r^2$$

The angular velocity $= \omega = 2 \pi n$.

Hence the rotative energy

$$\tfrac{1}{2} I_p \omega^2 = \tfrac{1}{2} (\tfrac{1}{2} M_1 r^2 + 0.3 M_2 r^2) 4 \pi^2 n^2$$

If the energy is required in foot-pounds per second we have:

$M_1 = 113 \div 7000g$,

$M_2 = 37 \div 7000g$,

$r = 0.154 \div 12$,

$n = 194{,}400 \div 60 = 3{,}240$ revolutions per second.

Substituting these values in the equation above and carrying out the calculation we get:

$$1/2\ I_p\ \omega^2 = 10 \text{ foot-pounds per second.}$$

This figure is of course negligible when we consider the 2,500 foot-pounds per second, or 4.5 H. P. which this small missile develops by virtue of its linear velocity at its maximum speed in flight.

The jacket of the bullet is composed not of steel as is commonly supposed, but of an alloy of 85 per cent copper and 15 per cent nickel. This metal possesses a high tensile strength which we find is quite necessary to prevent the jacket from stripping, *i. e.*, tearing apart and separating from the enclosed slug. The tearing effect of fouling in the rifling is of course an unknown factor, but we do find that the tensile strain set up by centrifugal force alone is very important and must be allowed for. Suppose we consider a small section of the bullet as a fly-wheel with the jacket acting as the rim, the thickness of which is about 0.020 inch, making the mean diameter 0.288 inch.

$$\text{The mean velocity of the rim} = V = \pi \times \frac{0.288}{12} \times 194{,}400 =$$

14,650 feet per minute $= \dfrac{14{,}650}{60} = 244$ feet per second.

The sum of the centrifugal (radial) forces of the whole rim of a fly-wheel is

$$F = \frac{Wv^2}{gR} = \frac{4\,W\,\pi^2\,Rr^2}{3{,}600\,g} = 0.000341\,WRr^2,$$

where F = centrifugal force in pounds,

W = weight of rim in pounds,

v = velocity of rim in feet per second,

g = 32.16,

R = mean radius of rim in feet,

r = revolutions per minute.

The resultant of half of this force tends to disrupt one half of the rim from the other half. The rupture is resisted by the two sections of the rim at each end of the diameter. The resultant of half the radial forces is to the sum of half of the radial forces as the diameter of a fly-wheel is to half its circumference, or

$$\frac{\text{resultant}}{\text{sum of half the radial forces}} = \frac{1}{\frac{1}{2}\pi};$$

$$\text{resultant} = \frac{2}{\pi} \times \text{sum of half of the radial forces}$$

$$= \frac{2}{\pi} \times \frac{0.000341\,WRr^2}{2} = 0.00010854\ WRr^2.$$

As this resultant force is resisted by the section at each end of the diameter, each section must resist a force

$$S = \frac{0.00010854\,WRr^2}{2} = 0.00005427\,WRr^2.$$

The weight of a rim of cupro-nickel, one square inch in section, is about 23.95 R pounds, R being in feet. Hence

$S = 0.0013\ R^2r^2$.

But as $v = \dfrac{2\pi Rr}{60}$, and $v^2 = \dfrac{4\pi^2 R^2 r^2}{3{,}600}$, we have

$$S = \frac{0.0013\,v^2 \times 3{,}600}{4\pi^2} = 7{,}070 \text{ pounds per square inch.}$$

Without doubt this is well within the safe stress for the metal used, but when one becomes familiar with the highly trying conditions to which it is subjected and appreciates the rapidity with which the bullet is accelerated within the rifle barrel, the uniformly satisfactory results obtained are surprising. The Ordnance Department and the commercial manufacturers are constantly at work to produce more efficient and more deadly ammunition and if the progress in the next few years is anything like that made since the Spanish-American war, the mechanical problems presented will be by no means inconsiderable, and will become as essential a part of bullet design as the ballistic problems are to-day.

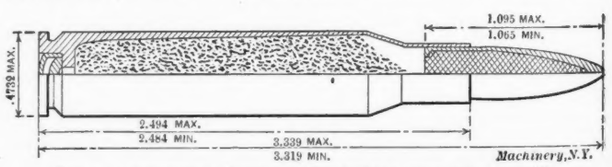

Fig. 3. Longitudinal Section of Springfield Army Rifle Cartridge with Spitzer Bullet

* * *

Mike.—Pat, man, me fortune is made!

Pat.—How is thot?

Mike.—I've invinted a machine for sweepin' the sthreets that will do the wurrk of six min.

Pat.—An' ye think ye're a great man to take the bread and butther out of the mouths of yere fellow min——

Mike (softly).—Hush, man! it takes siven min to wurrk the machine!

FORM GRINDING OPERATIONS IN THE SHOPS OF THE LANDIS TOOL CO.

RALPH E. FLANDERS*

The grinding wheel has found but a limited application for grinding other than plane, cylindrical and conical surfaces. In this respect its field is not so universal as that of the milling machine and the lathe, which readily adapt themselves to the use of form cutters and tools. In the grinder the difficulty lies in the shaping of the periphery of the wheel to the form it is desired to reproduce in the work. This operation offers more of a problem than in the case of a cutter or lathe tool, it being necessary to provide attachments with mechanical means for guiding a diamond point to follow the outline desired on the wheel surface. Despite this handicap, the Landis Tool Co., of Waynesboro, Pa., has found it profitable to make extensive use of such truing attachments for simple operations. Examples of work formed in this way are herewith illustrated and described.

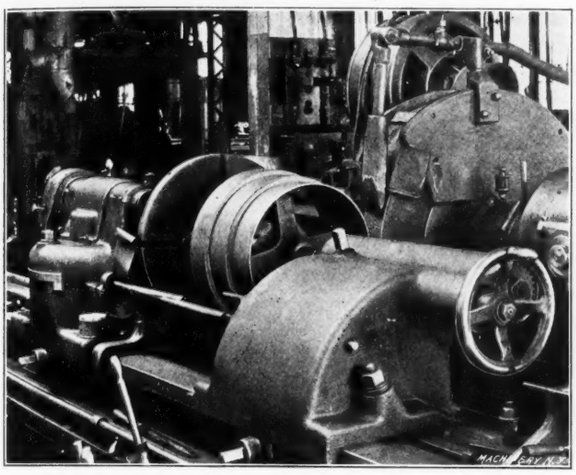

Fig. 1. Grinding the Crown on the Faces of Cone Pulleys in a Landis Grinder

Crowning Cone Pulleys

In Fig. 1 is shown a cone pulley, mounted in a large plain grinding machine, which carries a wheel shaped to give the desired crowning for the belt surface. To produce this, the wheel is concave to the proper radius and fed directly into the face of each step of the pulley, thus giving it the proper shape and the desired fineness of finish in the same operation.

The interest in this operation attaches, of course, to the means provided for grinding the concave contour on the wheel. The attachment shown in use in Fig. 2 is employed for this purpose. This consists, it will be seen, of a base mounted on the clamping surface of the work-table, and carrying a pivoted arm through which is adjustably mounted a swiveling diamond holder. This holder may be rotated about an approximately horizontal axis by means of the worm and worm gear and hand-wheel shown. By adjusting the arm about its pivot and the holder about the arm, the axis of the latter may be so located with reference to the wheel, that a concave surface of any reasonable radius may be cut out from the wheel. The adjustment is so flexible, in fact, that a practically straight, or even a convex surface can be produced on the wheel if it is required.

Grinding Fillets on Crank-shafts

Another example of form grinding occurs in the finishing of crank-shafts. The crank-pins and journals are provided with fillets at their junction with the cheeks of the crank. To produce a satisfactory job, these fillets should be formed by the edges of the wheel, which should be carefully shaped to the desired radius. Figs. 3 and 4 illustrate the fixture designed for this operation.

The frame of the fixture *A*, is mounted on top of the regular back-rest of the machine as shown. The diamond is set in the end of holder *B*, which is in turn supported by arm *C*, which swivels about axis *x x*. The radius to which the corner of the wheel is formed is determined by the distance from the point of the diamond to this axis. This radius is adjusted by thumb-screw *D*, suitable graduations (not shown in the engraving) being provided for making this adjustment. Holder *C* is supported at the upper end in the bearing in frame *A*. At the lower end it is provided with a roll *E*, which bears against a semi-circular seat in frame *A*, concentric with axis *x x*. By adjusting the nut and stud at *F*, thus clamping together the split shown in arm *C*, roll *E* is kept firmly pressed against its seat. This takes the thrust of the diamond against the wheel at the lower end of *C*. The diamond and its holder are rocked about axis *x x* by handle *G*, playing between stops *H*.

The operation of the device is as follows: The diamond in *B* having been adjusted by thumb-screw *D* and the graduations to the proper radius, stops *H* are set in the proper holes for the corner of the wheel to be trued. These stops give 90 degrees of movement, allowing the diamond to swing from the front face around to the side. Holding handle *G* in the position shown, so that the diamond is in front of the axis of rotation, the wheel is first trued up on its front face by the usual movement of the wheel back and forth past the diamond. When this has been trued up, without disturbing the cross feed of the wheel, the diamond is moved off to one side and handle *G* is rocked down to the 90 degree position on that side as determined by the stops. Rocking handle *G* back and forth through the 90 degrees, the table is gradually fed up to the corner of the wheel until the latter is completely rounded to the radius desired. For the other corner, handle *G* is brought back to the central position, stops *H* are changed to permit 90 degrees of movement in the other direction, and the diamond is fed back to the other corner, which is rounded in the same way.

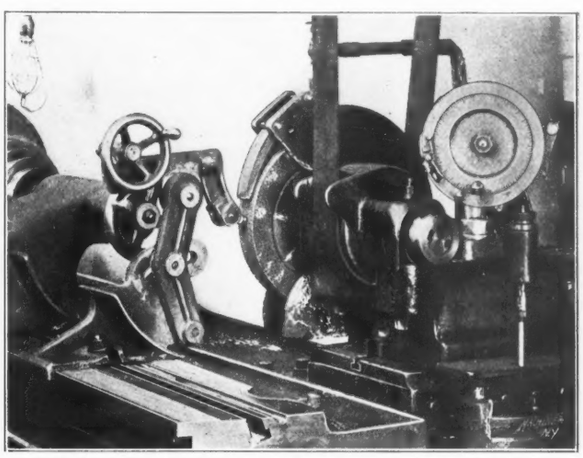

Fig. 2. Fixture for Shaping a Concave Face in the Wheel for Crowning Pulleys

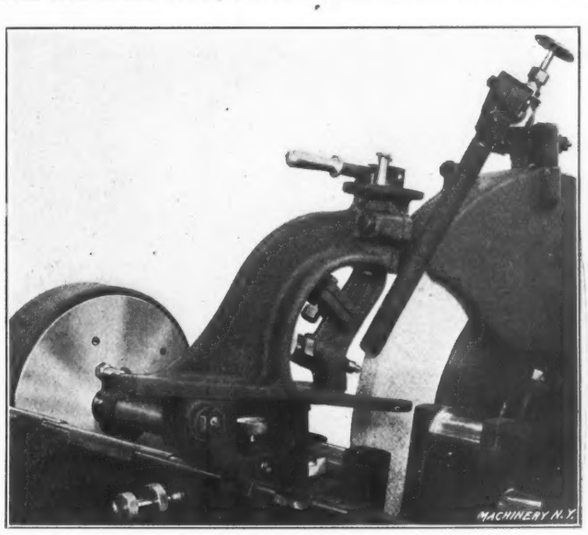

Fig. 3. Truing Device for Forming Wheel to Grind Fillets on Journals and Pins of Crank-shafts

* Associate Editor of MACHINERY.

Fig. 4 also shows quite plainly the construction of the regular back-rest used in the Landis grinding machine. The work is supported by two rests of maple at *J* and *K*. The lower rest *K* is mounted on a pivoted arm *L*, which may be swung toward or away from the work by thumb-screw *M*. This adjustment does not have to be changed often, since the variation in the height of the work makes practically no difference in the diameter. Thumb-screw *M* is therefore provided with a clamp-bolt at *N*. The upper rest *J* is mounted in the end of a plunger *O*, which is backed by thumb-screw *P*, having knurled lock screws *Q*. In long, slender cylindrical work this rest is constantly set up by the workman as the grinding progresses, the adjustment being made for each rest at a time when the wheel is at work at another part of the shaft; it is possible at that time to be guided by the sense of touch in setting up the back-rest. For crank-shaft grinding it is ordinarily not necessary to adjust the rests during the operation.

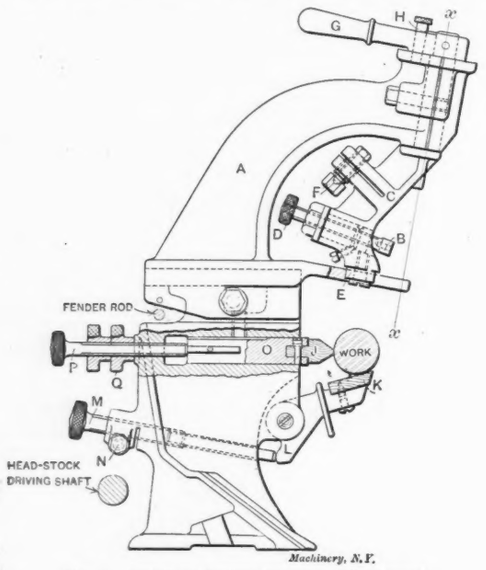

Fig. 4. Detail of Radius Forming Attachment

What may be considered a form grinding operation, though of the simplest order, is performed on the piece of work in

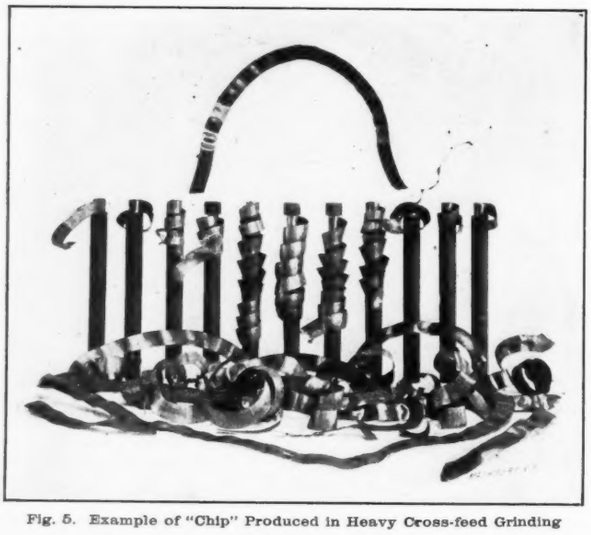

Fig. 5. Example of "Chip" Produced in Heavy Cross-feed Grinding

Fig. 6. This shows a wheel spindle for the Landis grinding machine. It will be noticed that a portion of the spindle at the right end is turned down to a small diameter to receive the thrust and adjustment collars. This shaft is case-hardened. Difficulty was experienced in the hardening from the breaking off of this ⅝-inch diameter extension. To remedy this, the present method is to carry the 1.488-inch diameter clear out to the end of the shaft at the right, and case-hardening it in that condition, the shaft being finished except for this portion. After hardening, the spindle is placed in the grinding machine again, and a wheel the full width of the part to be machined (that is to say, about 3 inches face) is used to grind below the case hardening. The wheel is not traversed back and forth as in ordinary grinding, but is fed straight in, reducing the diameter about 3/16 inch. It is then possible to finish the arbor at this point in the lathe, as the core of the spindle is soft. It will be seen that this is a form grinding operation, in spite of its simplicity.

An interesting, though now well-known, phenomenon is connected with this operation. If the hardness and grain of the wheel is exactly right, forcing it into the work with a heavy feed will produce a "chip" very strongly resembling that produced with a wide form tool under the same conditions.

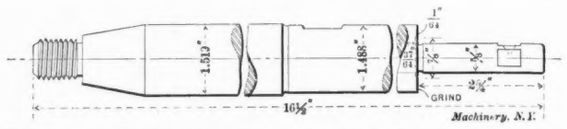

Fig. 6. A Grinding Machine Spindle; the ⅝-inch Diameter is machined after Case-hardening

When these chips first appeared, there was considerable discussion as to their nature, but it is now pretty definitely settled that they are formed of molten bits of metal, which rapidly accumulate and are fused together into the solid, ribbon-like form shown in Fig. 5. There is no advantage in producing these chips, but they are bound to appear if conditions are right for them.

* * *

THE SILVER DOLLAR CHECK SYSTEM

W. L. B.

When I was running a lathe in the old railroad shops at Scranton, a new man came in one morning and took a big lathe opposite mine. He was a country jay of the greenest kind, but he soon showed that he could do a good piece of work, though his queer way of doing it would make us wonder what kind of a country shop he came from. The boys gradually broke him in to our ways by their own gentle methods. Jim, who ran a lathe which was on the other side of the new man, was particularly active; he soon fixed up a game with one of the apprentice boys, and started right in. Jim called the boy, and pitching him a big silver dollar in a way to attract the attention of the country man, told him to go to the tool-room and get a file. The boy did so, and then, on the quiet, returned the dollar. Soon Jim called the boy and, again pitching him the silver dollar, told him to get a wrench, and so it went on, Jim calling the boy and every time giving him the dollar as he told him to get some tool.

The country man observed this careless exchange of money until he couldn't keep in any longer; then he asked Jim why he gave the boy a dollar every time he wanted a tool. Jim's chance had come and he started right in to improve it. He said that the rule of the place was that fifty cents had to be deposited for every tool taken from the tool-room, and when the tool was returned it was examined and a charge made for the wear. The other fifty cents was graft for the tool-room keeper, who was a crank and who wouldn't give the men any tools unless they put up the fifty cents which he put in his own pocket. Jim went on to say that it was useless to kick against the system as the foreman insisted on the work being done, and as they had to get the tools from the tool-room, there was no other way.

The country man was taking the bait fine, and in his interest he asked Jim how much he made a week. Jim said twelve dollars, but as his board was five and drinks five more and as the tools cost him a couple of dollars a day he was not getting along very fast.

Our country friend went back to his lathe in a dazed condition, and it was comical to watch the exceeding slowness with which the bright light of truth percolated that country head.

He made good in the shop all right, but for some reason he and Jim never became chums.

* * *

Brass for brazing should contain at least seventy-five per cent of copper in order to prevent its melting and flowing away during the brazing.—*Brass World.*

DON'TS FOR DRAFTSMEN*

JOHN S. MYERS†

Don't forget fillets.
Don't forget impact.
Don't omit oil holes.
Don't scoff at theory.
Don't omit oil grooves.
Don't omit dimensions.
Don't forget check-nuts.
Don't slight the details.
Don't repeat dimensions.
Don't use fancy lettering.
Don't show fancy oil grooves.
Don't claim credit not due you.
Don't despise accepted practice.
Don't crowd bolts too near ribs.
Don't work without a slide rule.
Don't be stingy about clearances.
Don't forget the value of graphics.
Don't start unprofitable arguments.
Don't be afraid to soil your hands.
Don't put foolish notes on a drawing.
Don't put unnecessary finish on parts.
Don't pretend to be what you are not.
Don't bend levers if it can be avoided.
Don't imagine you own the company.
Don't forget to allow for adjustments.
Don't get the patent bee in your bonnet.
Don't forget clearance for moving parts.
Don't be unpractical in applying theory.
Don't fail to keep notes on valuable points.
Don't repeat same detail in different views.
Don't put figures of no account on drawings.
Don't be timid or you will soon be a door-mat.
Don't leave too much for the tracer to fix up.
Don't go into needless refinement of figures.
Don't work all the time—recreation brightens.
Don't show plan view of nuts—life's too short.
Don't, if a checker, make unnecessary changes.
Don't raise a howl when asked to make changes.
Don't forget that blacksmith work is expensive.
Don't look for snaps—they are not worth having.
Don't be afraid to acknowledge you were wrong.
Don't think the company cannot do without you.
Don't make two parts where one will do the trick.
Don't think a checker has a cinch; try it yourself.
Don't be biased; keep your mind open to conviction.
Don't hesitate to make some original investigations.
Don't forget that looks sometimes sells the machine.
Don't make new patterns when old ones can be used.
Don't scale drawings when dimensions are available.
Don't provide awkward or poor means for lubrication.
Don't be disloyal to an employer who uses you square.
Don't forget the old saw, "Experience is a dear teacher."
Don't trust set-screws to deliver much power; use a key.
Don't forget that keys sometimes have to be drifted out.
Don't hold extended conversations during working hours.
Don't section line a lead pencil drawing except free-hand.
Don't forget that a little knowledge is a dangerous thing.
Don't use cast gears for high speeds; cut teeth are better.
Don't be afraid to show enough views to make things clear.
Don't use a slide-rule for calculations which must be exact.
Don't save ink—heavy lines and bold figures are the thing.
Don't put set-screws 180 degrees apart; 90 degrees is better.
Don't give dimensions in 32nds when 8ths are close enough.
Don't put ribs in tension if they can be put in compression.
Don't put important dimensions where they may be overlooked.
Don't be without one or two good papers bearing on your work.
Don't forget what class of workmen are to handle a machine.
Don't omit minor details; it causes endless confusion and delay.
Don't put a stud where a through bolt can just as readily be used.
Don't set down dimensions from scale until you have checked them.
Don't forget that any fool can criticize, but any fool cannot do.
Don't join a $\frac{5}{8}$-inch rib on a section 3 inches or 4 inches thick.
Don't lay a thing out when you can trace it from an old drawing.
Don't put dimensions on top of lines; make them out in the open.
Don't use any other kind of note-book but the loose leaf variety.
Don't forget that most calculations are at best but approximations.
Don't worry over infinitesimals or non-essentials—eliminate them.
Don't waste your noon hour—a trip through the shop will help you.
Don't be close-fisted with your data. Swap with your associates.
Don't balk at an excursion into the unknown; it may be profitable.
Don't imagine a man falls onto success like a blind pig into a well.
Don't stay out late with the boys—a big head is not a clear head.
Don't consider strength alone—rigidity is often the prime object.
Don't draw anything without some idea of how it is going to be machined.
Don't use standard nuts on parts much adjusted—use special long ones.
Don't trust to the eye for proportions of important parts—calculate them.
Don't hesitate about changing a drawing when the design can be improved.
Don't imagine every idea you get is a new one—this earth is fairly old.
Don't forget that drop forging saves money when in sufficient quantity.
Don't forget your ideas are your own if not worked up on the company's time.
Don't be unsystematic; you may thereby be going the longest way round.
Don't accept matters of opinion when matters of fact can be clearly shown.
Don't branch off onto matters extraneous to the points under consideration.
Don't hesitate to propose improvements or new ideas—you will gain thereby.
Don't make special parts when a standard part can be made to fill the bill.
If weak in the chest, don't be a draftsman—be a surveyor or get a milk route.
Don't forget it is easier to rub out lines on paper than to change iron and steel.
Don't wear cuffs; take off your coat and roll up your sleeves—be untrammeled.
Don't forget that good judgment is often the highest court of appeal in design.
Don't forget that your view-point might be changed if you owned stock in the company.
Don't locate holes which have to be laid out, in angular measure—give the chord.
Don't put bosses on opposite sides of forged levers if it can be avoided.
Don't expect to have everything ideal; you will nearly always have to compromise.
Don't tell all you know unless it doesn't take long, in which case it is immaterial.
Don't forget that a hand pointing to an important note will catch the workman's eye.

* For "Don'ts" previously published in MACHINERY see: Don'ts for the Blacksmith, February, 1909; Don'ts for Inventors, January, 1909; Don'ts for Machinists, March, 1908; More Draftsmen's Don'ts, June, 1906; Hard Lines for Draftsmen, October, 1905; Practical Don'ts for Machinists, 1, June, 1905; 2, January, 1906; 3, February, 1906.

† Address: 2456 Almond St., Philadelphia, Pa.

Don't change dimensions from your figures to the checker's until you have confirmed them.

Don't forget that the tracer wants to be a draftsman, and give him a chance whenever you can.

Don't forget to consider the pattern-maker and molder—their work costs money.

Don't search all over the room for a protractor; use your tables of sines and tangents.

Don't start a job until all the requirements and available data are secured and digested.

Don't refrain from calling attention to points you know the chief would like a say-so on.

Don't put 1/16-inch and ⅛-inch finish pads where ¼-inch and ½-inch ones can be used.

Don't forget that force travels in straight lines or else produces bending stresses.

Don't forget that curved ribs are more expensive in the pattern shop than straight ones.

Don't forget that new drawings of old parts can best be made directly on the tracing cloth.

Don't forget center lines. A circle without its center lines looks like a bald-headed man.

Don't forget that the company is not running an art gallery, but a manufacturing establishment.

Don't have too much all-abiding faith in the factor of safety to cover up inadequate design.

Don't get the graphic bug (or any other) in your head to the exclusion of better methods.

Don't put a lot of cored work on a "one-casting-only" job. A little extra metal is cheaper.

Don't disregard the erector; take the machine apart and assemble it while making the drawings.

Don't use dowel pins for heavy thrusts when fitted bolts or tongues can be used to advantage.

Don't have a different tool for each different line; a few simple ones save time in the end.

Don't forget the machinist when dimensioning; his dimensions should be from finished surfaces.

Don't use an over-hung pin if it can be supported on both ends as readily.

Don't ask the chief questions you can answer yourself by second thought or by the use of your eyes.

Don't imagine rough castings come just like the drawing; they vary and you must allow for it.

Don't set down a dimension without laying your scale on it—it is a mighty good check.

Don't be given to snap judgment. Have some foundation upon which to base your opinions.

Don't imagine that all parts have to be made in your own shop. Sometimes you can do better outside.

Don't use studs when tap-bolts make the part easier to remove, unless for other good reasons.

Don't say theory when you mean hypothesis; call a thing by its right name, whatever it be.

Don't make picture drawings for the workman—when such drawings are required, hire an artist.

Don't make extra machine work on parts to save a little metal unless weight is mighty important.

Don't form the whistling habit—it annoys others and distracts your own mind from the work.

Don't, when lines are close together, make arrows so the workman cannot tell which line they go to.

Don't forget that a change of position often kicks a man out of a bad rut.

Don't say "¾-inch cored holes" or "core ¾-inch holes for ⅝-inch bolts"—say ¾-inch core.

Don't say, "drill and tap for ¾-inch gas pipe"—it makes the machinist tired. Say ¾-inch pipe tap.

Don't put special threads on the drawing until you know how they are going to be cut.

Don't forget that cores require support and vent, and that provision must also be made for clearing them out.

Don't raise objections to everything proposed—manage to see the good points also.

Don't try to impose your personal opinions on others—remember the old woman who kissed the cow.

Don't change patterns for mere personal preferences of design—the next man may change them back again.

Don't think you are the whole show—there are others who have trouble before the design is working.

Don't put all dimensions on, then all arrow heads; you are sure to miss some of the latter by this method.

Don't forget that natural functions are quicker to use than logarithmic when multiplying by even figures.

Don't make changes in a half-hearted, dispirited, sloppy manner. Make them as good as the rest of the job.

Don't make parts right and left when it can be avoided, even if some changes in the drawing are necessary.

Don't mix styles of printing; for instance, italics and Roman, vertical and slanting, or backhand and vertical.

Don't forget that while you are young and single is the time to do your moving for a varied experience.

Don't lead ropes off the bottom of a drum when it can be avoided; they lead much better from the top.

Don't try to smoke and draw simultaneously—you don't enjoy the smoke and it interferes with your work.

Don't ask a tracer to do a job for you which takes longer to explain to him than it would to do it yourself.

Don't wait until the tracing is made before writing the bill of material; there are many good reasons for this.

Don't, unless an expert, attempt to dictate a proposal or specification without first roughly blocking it out.

Don't forget the value of free-hand sketching; it is a great aid towards securing a mental picture of what is required.

Don't waste time rubbing and redrawing which could be avoided by roughly sketching out the scheme first.

Don't commence a layout blindly when it is possible to secure a good mental picture of the requirements.

Don't forget the value of sections or little true plane projections of parts which are at an angle to the main body.

Don't put a ⅜-inch bolt or set-screw where a ⅝-inch or ¾-inch one would remove all doubt as to security.

Don't be industrious only when the chief is around, but plug away faithfully and you will some day be discovered.

Don't scoff at theory; theory is crystallized fact. There is a wide divergence between theory and hypothesis.

Don't forget to allow for the efficiency of various mechanisms; friction is often a very important factor.

Don't perform extended trigonometrical calculations when scaling a layout is sufficiently accurate and quicker.

Don't let a stop strike a moving part at a great distance from its center of percussion if it can be avoided.

Don't use abbreviations no one understands but yourself; *you* may even forget what they mean in a year or so.

Don't draw two arcs tangent for a reverse curve—they give a hump-backed appearance. Connect them by a straight line.

Don't forget the Lord did not make man with ribs on the outside of his body, and that smooth contours are pleasing.

Don't draw a moving part in a dozen different positions for clearance—trace it and shift the tracing over the layout.

Don't say, "Bore 6-inch diameter" or "6-inch diameter bored"—say bore 6-inch. (Any fool knows it is not square.)

Don't put little undercuts on castings; they seldom save much metal and cause the pattern-maker and molder lots of trouble.

Don't send a solid wheel out as a repair or additional part when it would save money in erection by having the wheel split.

Don't forget that the draftsman should be a designer, and to reach that stage he must study outside of working hours—life is short.

Don't undervalue the process of elimination when attempting to arrive at a decision where numerous factors are apparent.

Don't copy other concerns' designs; you may get your employer into trouble, and besides it is poor policy. Study designs, but don't copy.

Don't treat the shop man with contempt or disrespect; he knows a thing or two and dollars to doughnuts he's as much a man as you.

Don't destroy mechanical publications; save, at least, the articles you are interested in and file them in some way so that you can find what you are looking for.

Don't think that you know more than the chief; maybe you do on some things, but it is bad to look through glasses of that color.

Don't make shrouded pinions just a little wider than the gear; leave plenty of room, say (3/16 × pitch) + ¼ inch on each side of gear.

Don't try to draw all of one view first, work your different views up together, thus seeing the relation of parts; this is very important.

Don't use long compound names like "Second Intermediate Shaft Bearing"—call it "bearing." Assembly drawing should show where it goes.

Don't, when given a scheme to work out, immediately try to work in something else, but make the scheme given you work if possible.

Don't use gold where clay will do; for instance, if machinery steel case-hardened answers the purpose, what is the use of using tool steel?

Don't give up in despair when ideas will not come; take a little walk out into the shop, come back and try again. It helps wonderfully sometimes.

Don't imagine a shroud has to be thick for strength; it is entirely a matter of casting. Thickness = (¼ × pitch) + ¼ inch is writer's rule.

Don't repose explicit faith in figures when things look out of proportion—you may have made an error in calculating or a wrong assumption somewhere.

Don't leave a thing just good enough, or on the ragged edge, when opportunity exists for making it positively and absolutely adequate to all requirements.

Don't spoil the entire appearance of a machine by one or two cheap details; for instance, an unsightly rough lever, or an old bent flat for a bracket.

Don't waste too much time in explaining the mental processes whereby you fell in error; although if they can quickly and clearly be shown, it lets you down easier.

Don't imagine the workman only needs measurements from the pitch line for cut bevel gears. Give outside diameter, face and pitch angle, and backing from point of tooth.

Don't be ignorant of structural design because you are in a mechanical line; many of the principles are valuable in machine design.

Don't, if a boss, imagine your men will stay just to help you out when they can do better elsewhere; if you want to keep your men make it profitable for them to stay.

Don't prohibit the use of 2- and 4-inch scales; they are as readily scaled as the 1-inch-to-the-foot drawings and are often better in every way than 1½, 3, or 6-inch scales.

Don't forget that the stub tooth, of higher angle of obliquity than the present standard, is going to be the coming thing. (It is here now, but too few persons recognize it.)

Don't go to war without arms; for instance, don't tackle a job without preparation (especially a new line of work), or go out to measure up a job without a steel scale and calipers.

Don't run an old men's home or a kindergarten; either extreme is liable to require excessive philanthropy, for the old ones die and leave you, and the young ones leave of their own account.

Don't forget that multiplication of parts costs in clerical work on orders, cost accounts, etc., besides being more parts for the erector to handle and to carry in stock, and for the user to replace.

Don't be helpless if required to do a simple mechanical job just because you are a structural man—acquire a certain amount of general knowledge; it will be very helpful even in your special line.

Don't use thin nuts where standard ones will do just as well; for thin nuts are generally made from standard ones, therefore cost more; and standard nuts avoid all doubt as to the old check-nut argument.

Don't imagine thought grooves can be readily obliterated; it is doubtful if they can ever be filled up entirely. Start a new and better groove; wear it deeper by using it oftener and thus short circuit the old path.

Don't imagine an idea to be valueless, or a man incompetent, on account of being old; old is but a comparative term, and age is a condition, not a quality. The condition may indicate certain qualities, but they vary with the individual.

Don't forget that kinetic energy varies as the square of the velocity; this fact sometimes changes the complexion of things.

Don't forget that weight varies as the cube of like dimensions and that a part twice as large as another therefore weighs eight times as much, and if rotating at the same angular velocity has $2^3 \times 2^2 = 32$ times the energy of the part one-half as large.

* * *

GOOD AND BAD DESIGNS OF OFFSET LEVERS

JOHN S. MYERS*

Don't make levers like Figs. 1 and 3; make them like Figs. 2 and 4, and thus avoid excessive torsional stresses and resultant deflections. The reason is as follows: On section *AA*, Fig. 1, the bending moment equals *Pl* and the torsional moment equals Pl_1; on section *BB* the bending moment equals Pl_2, and the torsional moment equals Pl_3. Thin rectangular pieces are not suitable for torsion, hence the form illustrated in Fig. 1 will be subject to excessive deflection as compared with Fig. 2 in which the weight of the lever is the same or even less.

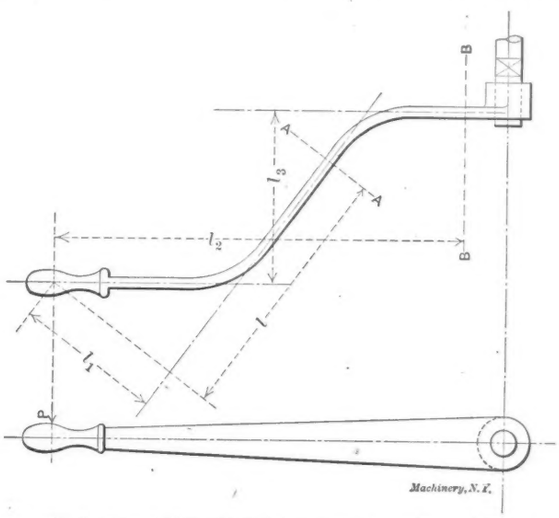

Fig. 1. Poor Design of Offset Lever; Torsional Moment High

In Fig. 2 the bending moment on section *BB* equals *Pl*, and the torsional moment equals Pl_1. The reduction in torsion in comparison with Fig. 1 is evident. With the same rectangular section Fig. 2 will not suffer the same torsional deflection as is shown in Fig. 1.

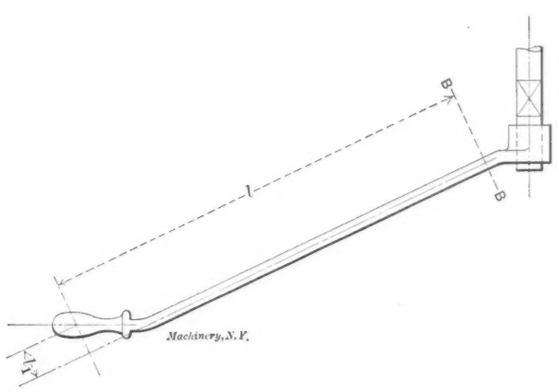

Fig. 2. Good Design of Offset Lever; Torsional Moment Low

The same principle is illustrated in the clutch lever in Figs. 3 and 4. The sections *AA* and A_1A_1 are each subjected to a torsional moment equal to ½ *Pl* in addition to a bending moment equal to ½ Wl_1. The torsional deformation causes excessive deflection and much higher fiber stresses than

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the designer is likely to anticipate, if he has not given the matter consideration.

The preferable form is that shown in Fig. 4. The sections AA and A_1A_1 are subjected to bending only, the moment on

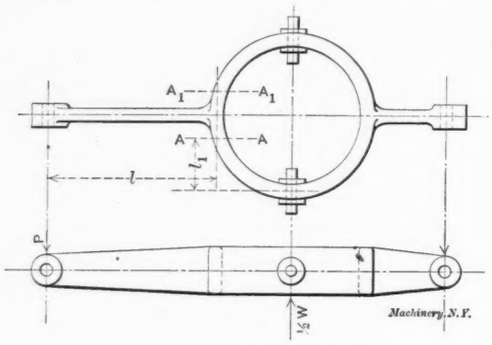


Fig. 3. Poor Design of Clutch Lever

each being equal to $\frac{1}{2}\ Pl$. The tension in the top fibers t and t_1 in consequence requires a thrust T to balance it. This puts the top fibers of the cross-piece C in compression, and

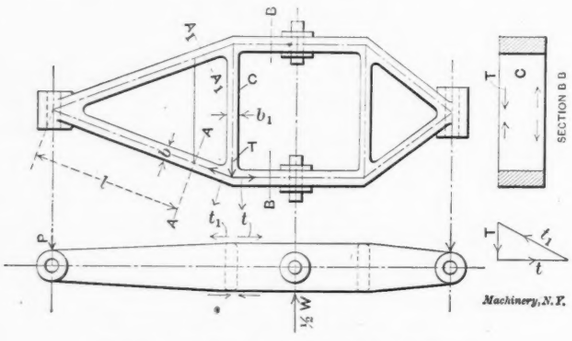


Fig. 4. Preferred Form of Clutch Lever Design

the lower fibers in tension. (See section BB.) To determine the value of T, calculate the unit stress t_1 and lay out as shown to the right. Scale off T and multiply by $b \div b_1$. The product is the unit stress in C.

* * *

An ingenious camera has been devised for recording the speed of automobile speed violators and furnishing the evidence to convict them in court. The camera is the invention of Professors D. F. Comstock and H. T. Kalmus of the Massachusetts Institute of Technology. It comprises two plate holders and a stop watch, and is so constructed that a picture of the stop watch appears in each exposure, thus giving an automatic record of the time elapsed between each exposure. The operator takes his place on the highway where speed violators pass, within focusing distance of the road. When a speeding automobile passes a certain point, the upper plate in the camera is exposed, and the second plate is exposed at another angle as soon as possible thereafter. A simple mathematical calculation enables the exact distance traveled to be deduced, and the watch face pictures record the exact time elapsed between the two points, thus making irrefutable evidence of the speed.

* * *

No sooner had flying machines of various types become successful enough to command the attention of military experts than the latter began to busy themselves to invent means of destruction of dirigible balloons and aeroplanes. The Krupp firm has a special department devoted to the construction of guns intended for disabling air ships, and two models have been brought out, one for discharging explosive shells and another for throwing a burning projectile, and it is, perhaps, no exaggeration to say that as much genius and energy is expended on these means of destruction as is expended on the constructive work in perfecting the flying machines. This is the price great nations pay for being world powers.

EXPERIENCES OF A YOUNG TOOLMAKER

T. COVEY

After an experience of about two years in a machine shop Jim the apprentice boy had proved that there was material in him for a first class mechanic. He was able to do good work on many of the machines, and had also spent some time in the erecting room. Jim was anxious to become proficient in every branch of the trade, and therefore he hailed with delight an order to report to the toolroom foreman. From this point we will follow him for a while and see how he and the average apprentice obtains his knowledge of the trade.

Mr. Corbin, the foreman of the toolroom in which Jim was to work, was also in charge of the blacksmith shop, storehouse, and the oil room, and consequently his time was so taken up with matters that the firm considered more important, that he really was unable to devote the time and personal attention to training his apprentice boys that he would have liked to. These conditions exist in a great many of our shops throughout the country, and the natural consequence is that boys are thrown on their own resources and left to "pick up" the business as best they can; and it is a fact that they get their training mostly from the journeymen with whom they work, whose instructions are sometimes good and sometimes bad. Mr. Corbin realized this condition, and the advice that he gave to Jim could be summed up in these words: "Keep your eyes open and think for yourself; if you get stuck don't be afraid to ask questions."

Jim's first job was to make a dozen 1½-inch novo steel end-mills, with straight flutes, or teeth. He was given the stock and a finished end-mill in good condition as a sample, and was told that he could get a gage for the shanks from one of the boys that passed out tools. He was also instructed to leave the straight portion 1/32 inch large, and to allow the shanks to project 3/16 of an inch through the gage. Jim carried the stock to a vacant place on the bench and proceeded to center it. When this was done he asked the foreman what lathe he was to use, and was told to use any idle machine that was suitable for his work. He found a Hendey-Norton lathe with a taper attachment that was not in use, and went ahead with his work on that. After getting the gage out of the tool department, he tried it on the shank of the sample mill that he had been given and found that the shank projected ⅜-inch; turning to the man working next to him he remarked that he guessed that the foreman was afraid to let him turn his work to size.

"How is that?" the man asked.

"Why he told me to leave the straight portion of these mills about 1/32 inch large, and to allow the shanks to project 3/16 inch through this gage; this sample projects ⅜ inch."

"Well that is all right—we all turn them that way. It is done to leave stock for grinding after the mills are hardened. You will notice that the gage you have is marked plainly 'No. 9 Brown & Sharpe taper, Tang to project ⅜ inch.' These gages were made up to insure uniform results in making taper shanks. This is a female gage (B Fig. 1) and is made ⅛ inch longer on the large end than the standard taper; this is done to make sure that the socket will not strike on any shoulder that may be left on the shank before the taper fits properly. The male gage (A Fig. 1) of this size is made the proper length and size except that the small end is about 1/16 inch longer than the standard. If you were to try gages of this size together, you would find that the male gage was apparently too small (or the female gage too large) as it would project 1/16 inch through the small end of the female gage, and the large end of the latter would overlap the large end of the male gage ⅛ inch. But you will readily see that if a shank fitted to the female gage be placed in a socket fitted to a male gage, the small end will not go home by 1/16 inch, and there will be a portion of the shank at least ⅛ inch long extending out of the socket. (See Fig. 2.) This allows for driving the shanks in until they fit tight, and also for wear to a certain extent. I don't think you will find gages like these in every tool-room, but there should be."

"Yes, I should think they were a good thing," Jim replied. "By the way, what should the taper be for a No. 9 Brown & Sharpe shank?"

"All Brown & Sharpe tapers, except No. 10, are ½ inch to the foot. No. 10 has 0.5161 inch to the foot. Morse tapers vary from 0.600 to 0.630 inch per foot. There is a blue-print over there mounted on a board giving all the dimensions in detail for both Brown & Sharpe and Morse tapers of all sizes."

"Thank you," said Jim, "I begin to see that there is more to this job than I thought"; and he proceeded to turn up his mills without any trouble until he wanted to recess the ends. Then he went to the man again and asked: "How would you put this recess in the ends of the mills? Chuck one end and run the other in the steady-rest?"

"Well, of course you could do it that way, but there is an easier and much quicker way. All of our lathes in here are fitted with half centers (Fig. 3), and to cut out that recess you should replace the regular center with one of these half centers, placing the cut out portion toward the front of the lathe, and then use a regular boring, or hook tool to make the recess. Of course you will be cutting out the center, but when it gets too small to hold the work safely the mill can be removed and the center drilled deeper with a combination center drill and reamer. I usually face the ends of my mills and put the recess in first, because if the drill runs off a little in re-centering it is less liable to do damage."

Jim followed instructions and completed his work in the lathe. Upon looking for a milling machine in which to complete his job, he found them all in use. One man named George was nearly through and Jim asked him how much longer he would be in the machine.

"About ten minutes," said George.

"How many teeth are you cutting in that reamer?"

"Twelve."

"Good! Just what I want. I'll clean up the lathe I was using and you will be through by that time," and he was.

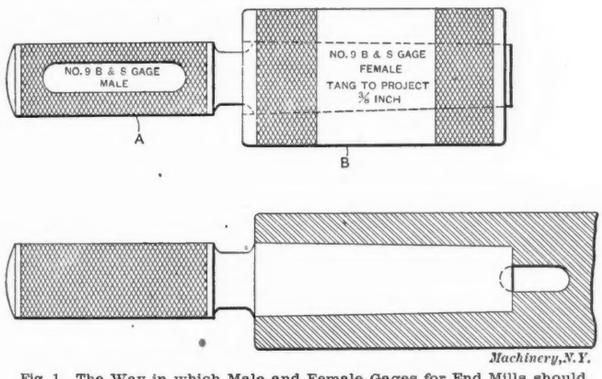


Fig. 1. The Way in which Male and Female Gages for End Mills should fit together, and Male Gage properly fitted into Socket

Jim put one of the mills in the machine, and was starting to mill the teeth when Mr. Corbin came up and said, "You should mill the tangs first then you can put the shanks in a collet, place it in the index head and mill the teeth. You would have to hold them in a collet to mill the ends, and if the tangs are not milled the shanks will not fit."

While Jim was milling the tangs he noticed that the index pin of the dividing head was in the 21-hole circle, and looking at the table he saw that for twelve divisions it gave 3 turns and 13 holes in the 39-hole circle. Going over to George, he said: "How is this? You said that you were cutting 12 teeth in that machine and the index pin is in the 21-hole circle."

"The machine is set up for twelve divisions, and I just cut twelve teeth on this reamer," said George.

"But for twelve divisions the table gives 3 turns and 13 holes in the 39-hole circle."

"Well I seldom use the table. I index in the quickest way and I don't change the index plates unless it is necessary."

"Then there must be other circles you can use instead of the ones given in the table?"

"Yes, in most cases there are."

"But how do you tell which ones they are?"

"I figure it out."

"You must be good at figures if you can do that quicker than you can look it up in the table, or change the index plates either. How do you do it?"

"Well it's simple enough when you understand it. You know that the ordinary index head is in the ratio of 40 to 1, that is, it takes 40 turns of the index handle to make one turn of the spindle. Now I'll give you the little rule I use. It will work on any index head of any ratio. You take the ratio, to 1, of the index head and put it down as the numerator of a fraction, and use the number of divisions you wish to make as the denominator, like this: 40/12. Now reduce this to a mixed number and you have 3, and 4/12. There it is, the

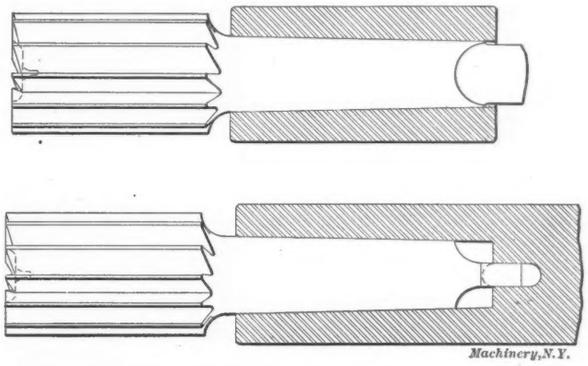


Fig. 2. Shank of an End Mill properly fitted to the Gage and Socket

whole number represents the number of turns; the numerator of the fraction, the number of holes and the denominator the circle. You learned at school that you could multiply or divide both terms of a fraction by the same number without changing its value. Now we will divide both terms of this fraction by 4 which reduces it to its lowest terms, or 1/3. So to get 12 divisions the index handle must be turned three and one-third times, no matter what circle you use; and it is plain that any circle having a number of holes that can be evenly divided by 3 may be used. For instance, $18 \div 3 = 6$, or 6 holes in the 18-hole circle; $21 \div 3 = 7$, or 7 holes in the 21-hole circle, and so on."

"That looks easy," said Jim.

"Yes, and it is easy," replied George. "You try it every time you have a job of indexing to do, and you will soon find that you can do it without pencil and paper, and it will save you lots of time hunting up tables and changing index plates."

Jim got on fairly well in milling the teeth; only making one mistake in indexing by failing to move the marker the one-third turn. He told the foreman about it, and Mr. Corbin replied that that would not spoil the mill entirely, but he should be careful about such things. As Jim was finishing up this operation he began to think about how the machine was to be set up for milling the teeth on the ends, but could reach no satisfactory conclusion. Going over to George he said: "Say, I am a little puzzled as to how to mill the teeth on the ends of these mills. Will you kindly give me a few suggestions?"

"I'll help you all I can," said George. "What is the angle of the cutter that you used on the flutes?"

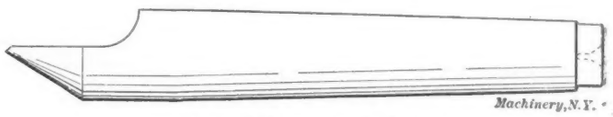


Fig. 3. Half-center for the Lathe

"I don't know," said Jim. "I took the sample mill to the window and asked for a cutter like the one used in making it."

"Well it should be 60 degrees, as that is what we use on the flutes or side teeth of practically all mills, and for cutting the teeth on the ends we generally use 70-degree cutters. The reason for this is that the teeth on the ends do not want to be as deep as they do on the sides, as the chip room would not be in proportion to the work the teeth are to do; the teeth would also be weak on the corner where the most work is done. First tip the index head up to about 75 degrees from the horizontal, but don't be particular about the setting, as you will have to make changes after taking a couple of trial cuts in order to get the lands of equal width from the outside

to the center. Tables have been figured out that will give you the angle to which the head should be set for a certain number of teeth and for a cutter of specified angle, but there are so many varying conditions affecting this angle that it would have to be a pretty elaborate table to cover them all, and even then the errors in the angles of the cutters due to grinding would be sufficient to make at least one trial cut necessary to get the correct angle. As you are cutting a right-hand mill you should get a left-hand 70-degree cutter and place it on the arbor with the side that is at right angles to the hole next to or facing the spindle of the machine. Set the saddle of the machine so that this side of the cutter is in line with the index centers. Move the table over until the index head is at the right-hand side of the cutter or spindle, or loosen the head and move it along the table if necessary; then place the mill in the collet, bring it up to the cutter and revolve the index head until the edge of a tooth just comes in line with the edge of the cutter. Then move the saddle in four or five thousandths so that you will not score the teeth on the side of the mill, and take a cut, being careful not to go too deep. When one tooth is finished index for the next and take another cut. This will give you one land; if it is wider at the center than at the outer edge, tip the head up a little more and take another cut. If the index is turned so that the work revolves in the opposite direction to the hands of a watch, as you are looking down upon it, each new cut you make will give you a land true with the last change you made in the angle of the head, but if you turn it in the opposite direction, two cuts will be necessary after each change to secure a true land. After you get the land perfect note what angle the head is set to, and remember it, as you will have to swing the head back to a horizontal position each time you wish to remove a mill before you can drive it out. After the ends are milled take a file and smooth off the face of the teeth, so that they will have the appearance of matching perfectly, as it is practically impossible to match the two cuts so perfectly that no difference can be noticed, and the error always appears greater than it really is. I guess you will be able to get on all right now, and if you don't I am always willing to help you to the extent of my ability."

"Thank you," said Jim, "I think I understand it much better now."

On getting the teeth all milled and the faces smoothed off Jim took them to Mr. Corbin for his inspection.

"They are all right except that you have not marked them," said Mr. Corbin. They should be marked 1½ inch on the large end of the shank, and the brand of steel underneath the size. Never make up a tool without marking on it plainly the brand of steel of which it is made. There are a great many different kinds of tool steel, and they are nearly all treated differently in tempering. No tool hardener can be sure of results unless he knows what steel he is handling. When you get your mills marked, turn them in and I will send them over to the blacksmith shop to be hardened."

* * *

An interesting method for producing an internal thread in castings while in the mold is referred to in a recent issue of the *Brass World*. This method can be used in cases where a good fit between the screw and the internal thread is not required and it obviates the need of tapping out the hole in the usual manner. Wire of about the same diameter as the pitch of the thread of the screw is bent in the form of a helix or spiral, with the coils closed up and inserted in the mold. The metal is cast around it and holds it firmly in place. The wire then forms a thread which will fairly well fit the screw. While this method would not answer the requirements for high-class work, it gives satisfactory service for many classes of low-grade machinery.

* * *

A fuel testing plant is being established by the Canadian government for investigating the natural fuel supplies of Canada. An important field of investigation will be that of peat, which is found in immense quantities in both Ontario and Quebec, and an attempt will be made to discover a method of using it successfully in gas producers.

DETERMINING THE ACTUAL COMPRESSION IN A SMALL GAS ENGINE

GEORGE M. STROMBECK*

Upon the proper compression of the explosive mixture in a gas engine depends the power and economy of the machine. This, together with the rapidly increasing number of gas (and gasoline) engines in the small and medium sizes, gives importance to methods of determining the compression. The simplest and most satisfactory way is by the use of a gas engine indicator which not only gives the compression, but also the force of the explosion. The compression alone can be obtained by the use of an ordinary steam gage, attached in the following manner: Next to the engine is placed a steam valve, opening into a check valve beyond which is a small air-tight chamber holding the gage. To determine the compression, run the engine, with the steam valve closed, until it is thoroughly warmed; then cut out the ignition and immediately after explosions have ceased open the valve. A few strokes of the piston will produce compression pressure

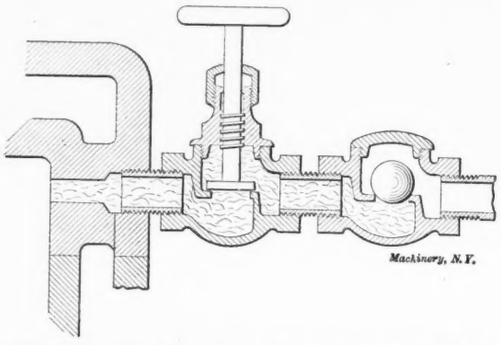


Fig. 1. When determining Compression by the Use of a Gage, Allowance should be made for the Increased Space indicated by the Shaded Portion

in the small equalizing chamber holding the gage. The check valve serves to keep this pressure constant.

If neither indicator nor steam gage is at hand, a very close estimate of the compression can be made by filling the compression space (the space beyond the piston when it is nearest the head) with water, care being taken that no pockets are left containing air. The most convenient way is to either weigh or measure a quantity of water, then fill the engine and determine how much remains. The difference will give the volume of the compression space (one cubic inch of water weighs 0.577 ounce.) After thus filling an engine with water it should be run a while to prevent rusting. Gasoline may be used in place of water. To the volume of the compression space thus found add the piston displacement (the product of the area of the bore of the cylinder and the stroke). This gives the volume of the fresh charge.

It has been found that the relation between pressure and volume of a charge that is being compressed in a gas engine is very closely represented by

$$P\sqrt[3]{V} = \text{a constant},$$

where P is absolute pressure in pounds per square inch and V is the corresponding volume. In gasoline engines the inflowing air must have a certain velocity to vaporize the gasoline. To produce this velocity requires a vacuum of two or three pounds per square inch. For this reason the pressure at the end of the suction stroke may be taken at 12 pounds above absolute vacuum. Knowing the volume and pressure at the beginning, and the volume at the end of the stroke the compression is found by use of the following equation:

$$P_1 V_1 \sqrt[3]{V_1} = P_2 V_2 \sqrt[3]{V_2}$$

$$P_2 = \frac{P_1 V_1 \sqrt[3]{V_1}}{V_2 \sqrt[3]{V_2}}$$

The cube roots of the volume may be taken from a table of cube roots. From the value of P_2 thus obtained subtract 15 pounds for atmospheric pressure, and the remainder will be the compression of the engine.

* Address: 333 Third Ave., East Moline, Ill.

If the compression is obtained with the gas engine indicator, or steam gage, allowance must be made for the increase in the compression space due to the volume in the indicator and fittings, in one case, and steam valve and check valve as far as to the valve seat in the other case. The space beyond the check valve being sealed from the engine need not be considered. The spaces in question are shown shaded in the illustrations. That even a very little addition to the compression space will cause serious error in indicating small engines, will be shown by an example from actual practice. An engine having a bore of 4¾ inches and a stroke of 5½ inches had a compression of 78 pounds when indicated. What was the compression with the indicator removed?

The volume of the air space in the indicator and fittings was measured with gasoline and found to be 2.3 cubic inches, which ought therefore to be added to the compression space.

Knowing the compression space in the indicator and fittings, that in the engine is readily computed as follows:

The piston displacement is

15.03 sq. in. (area of bore) × 5.5 in. (stroke) = 82.7 cu. in.

$P_1 = 12$ pounds absolute = pressure at beginning of stroke,

$P_2 = 15$ pounds (atmospheric) + 78 pounds (gage) = 93 pounds absolute = pressure at end of stroke.

Determine first the original volume of the gases compressed into the indicator. In the equation

$P_1 v_1 \sqrt[3]{v_1} = P_2 v_2 \sqrt[3]{v_2}$ all but v_1 are known. $v_2 = 2.3$ cubic inches = volume in indicator.

$$v_1 \sqrt[3]{v_1} = \tfrac{93}{12} \times 2.3 \sqrt[3]{2.3} = 23.5$$

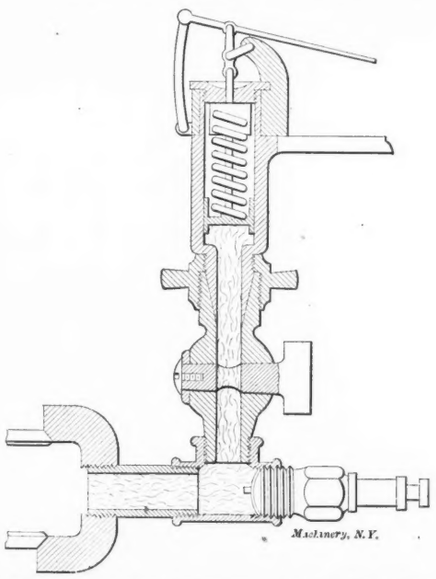


Fig. 2. When determining Compression by the Use of an Indicator, Allowance should be made for the Increased Space indicated by the Shaded Portion

From a table of cube roots pick out the number which when multiplied by its cube root will give 23.5, or

$$\sqrt[3]{v_1^4} = 23.5 \quad v_1^4 = 23.5^3 = 12{,}980$$

Extracting the square root twice $v_1 = 10.67$ cubic inches. Or solve with the aid of logarithms.

Of these 10.67 cubic inches, 10.67 — 2.3 = 8.37 cubic inches, originally occupied part of the space swept through by the piston. The rest of the gases displaced by the piston (82.7 — 8.37 = 74.33 cubic inches) must have been compressed into the normal compression space of the engine, which is the space to be determined. Since the pressure was the same in the engine as in the indicator, the relative size of the two parts of the compression space, in the engine and in the indicator, was proportional to the amount of additional gas forced into each, or

$$V_2 : v_2 \ (= 2.3 \text{ cubic inches}) :: 74.33 : 8\ 37$$
$$V_2 = 20.4 \text{ cubic inches.}$$

By actual measurement with water and computation the compression space was placed at 20.57 cubic inches, a difference of less than one per cent from value above deduced. Having determined the normal compression space in the engine, the true compression is easily obtained:

Let $P_1 = 12$ pounds = absolute pressure at beginning,

$V_1 = 20.4$ (compression space) + 82.7 (piston displacement) = 103.1 cubic inches,

$V_2 = 20.4$ (compression space) cubic inches.

Find P_2:

$$P_1 V_1 \sqrt[3]{V_1} = P_2 V_2 \sqrt[3]{V_2}$$

$$P_2 = \frac{12 \times 103.1 \sqrt[3]{103.1}}{20.4 \sqrt[3]{20\ 4}} = 104 \text{ pounds absolute.}$$

104 — 15 = 89 pounds = true compression, which is 11 pounds higher than shown by indicator.

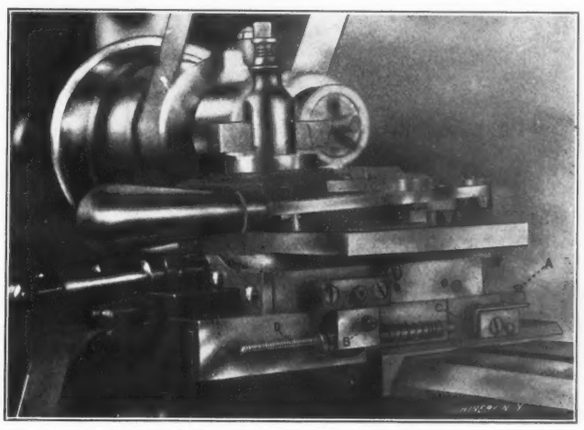


Fig. 1. Attachment for Automatically Starting and Stopping Bench Lathes

From this it is clear that in determining the compression by the use of an indicator or steam gage, one may be led to very erroneous conclusions unless the proper correction is made. The error will be larger, the smaller the engine or the larger the space in the indicator.

* * *

SOME INTERESTING SHOP APPLIANCES

When bench lathes are being used for turning small parts that have to be put in and taken out of the chuck by hand, the usual method of starting and stopping is by operating a belt shifter, or switch by a foot-lever. A method of starting and stopping these machines is employed in the shops of Adolph Muehlmatt of Cincinnati, whereby the control is entirely automatic. When on a job such as just outlined,

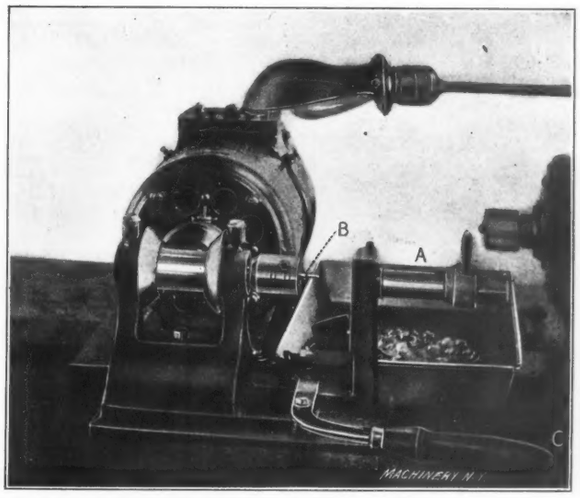


Fig. 2. Simple Form of Electrically-driven Tapping Machine

the switch wires of the motor are connected at *A* and *B*, Fig. 1. As the tool carriage is pushed forward to the work, the circuit is closed at *C* and the motor starts. When the cut is finished and the carriage is drawn back, the circuit is broken and the motor stops. The long screw *D* which is adjusted by the knurled thumb-nut shown, allows the circuit to be opened or closed at any point desired.

The engraving Fig. 2 shows a motor-driven tapping machine employed in these shops which will doubtless be of

interest. *A* carries a split chuck for holding the work and *C* is the lever which moves the work up to the tap. The spindle which carries the tap *B* is loose endwise so that it will not revolve either way when not in use; but, with the motor running right hand, as soon as the work is pressed against the tap, the end play of the spindle allows it to move over far enough to engage the pulley on the motor shaft and the tap is then fed into the work. By retarding the carriage the other pulley is caused to turn, and the tap is backed out. A girl can work this tool with great rapidity.

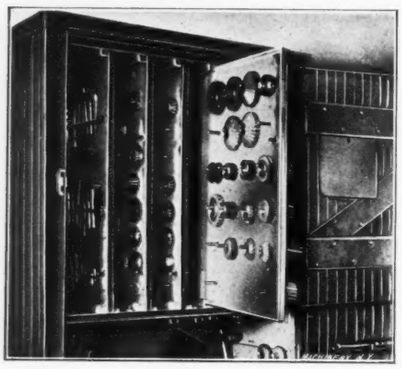


Fig. 3. A Compact Form of Cutter Cupboard

A very compact closet for milling-cutters is shown in Fig. 3. This closet has upright board partitions that slide in and out and they are hinged so that when they are pulled out against the stops they can be swung either way.

Fig. 4 shows one of the most compact batteries of small punch presses that I have ever seen. The motors and presses are all easily accessible, which is a point sometimes lost sight of in attempts to crowd a number of machines in a small space.

E. V.

* * *

BOB'S BALKY PUMP

C. TUELLS

Bob was a good-natured, curly-headed apprentice boy in the best and largest machine shop in town. He had passed the days when the men used to send him to the blacksmith shop to get the teeth of a file drawn out a little longer, or to the stock room for a half-inch counterbore with a five-eighths

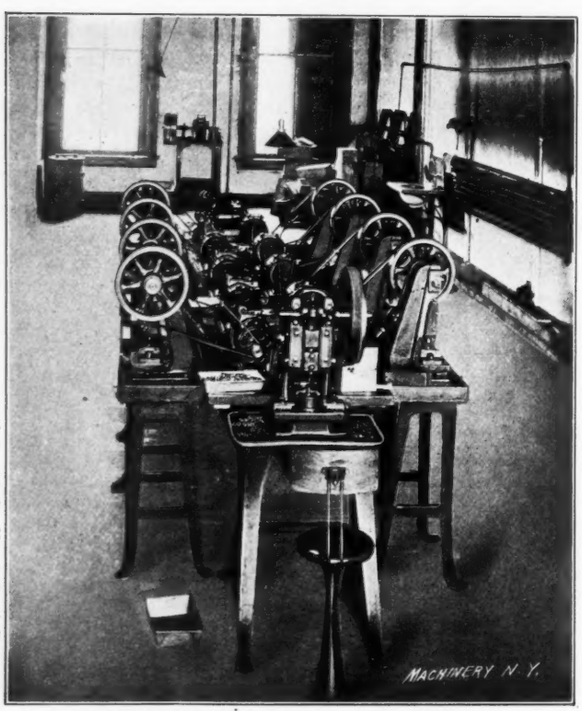


Fig. 4. A Compact Battery of Punch Presses

pilot. As he was in his second year, he got fairly good work—compared with turning pulleys and snagging castings, or running errands and "chasing the broom."

He was now at that stage of the trade where he was commencing to earn a little money for the company, for he could make a simple machine or a plain jig as well as most of the journeymen, and there was quite a difference between his thirteen cents an hour and the journeyman's thirty, which went on the right side of the books.

One day the boss brought around the blue-prints and castings for a rotary pump and gave Bob instructions how to make it. It was his first pump, so with all the vigor of ambitious youth he "waded into his job." He bored out his casting for the pump casing, turned up his gear blanks, and made his union as good and as quickly as the best of the men could do. True, he slipped up cutting one of the gears, but he hustled out a new blank, and this time his gears were cut the right number of teeth and the proper pitch.

After three or four days of interesting work his pump was completed and ready to be tested before being sent out of the shop. In "trying out" a rotary pump, it was customary to set it up on the ways of an old lathe, with the pump spindle in the chuck and the inlet and outlet pipes reaching to the floor into buckets; in this way, by starting the lathe, a bucketful of water was pumped from one bucket to the other, when everything went right.

Well, Bob got his pump set up all right, and it pumped, and pumped good, too. After pumping a few bucketfuls he shut

"There was nothing doing at the outlet end, and all attempts to make it pump were in vain"

off the power and went to get the boss to inspect the pump and see it work—his mind in that harmonious state that always accompanies a successful job.

In the meantime, two of Bob's brother apprentices conceived the brilliant idea of inserting a large cork stopper in the end of the inlet pipe and pushing it up out of sight.

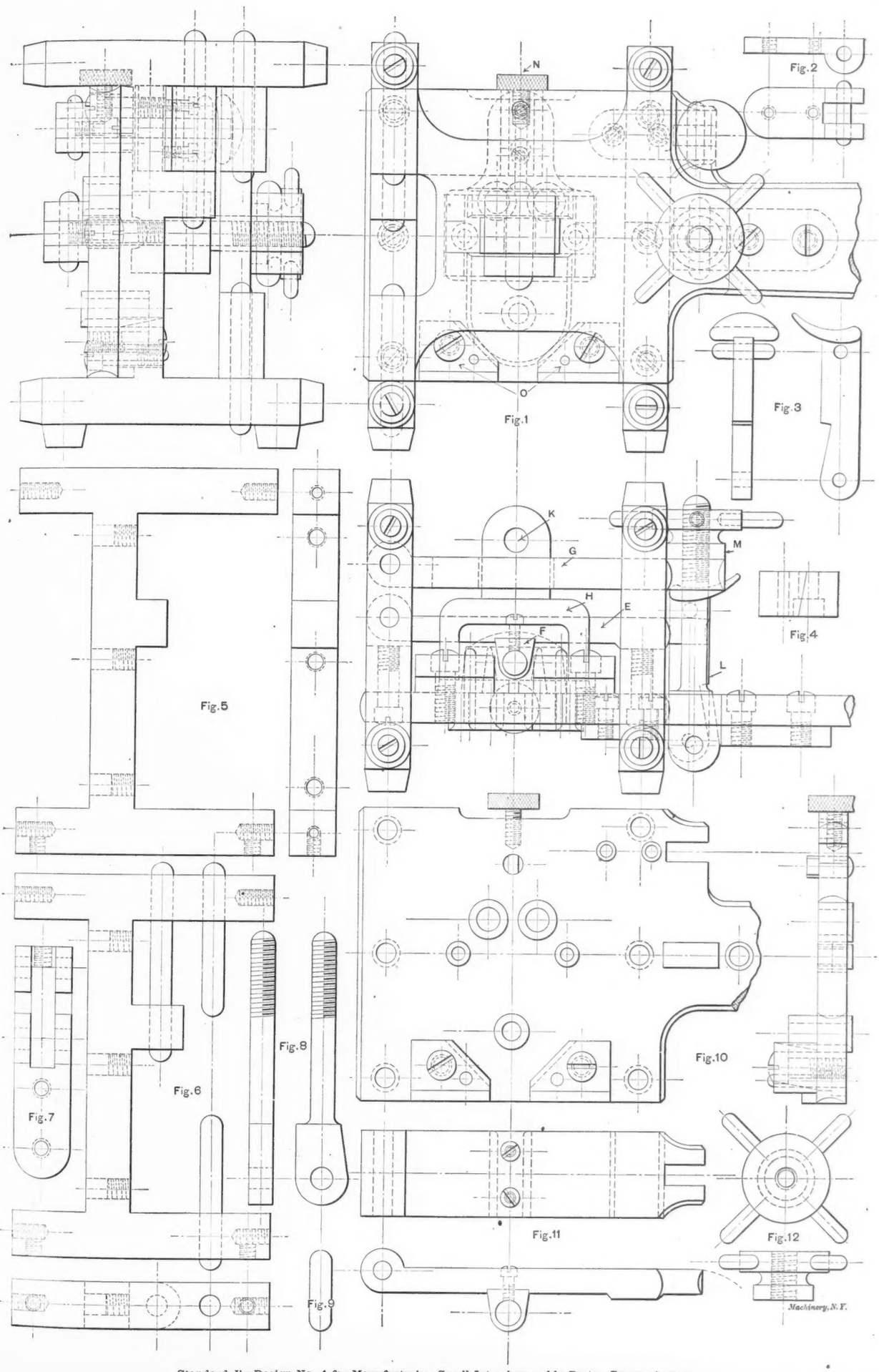
Bob soon came back with the boss, who, after looking it all over, ordered him to start the pump. The pump started all right, but, strange to say, there was "nothing doing" at the outlet end, much to Bob's astonishment, and all attempts to make it pump were in vain.

The boss looked dubious and Bob looked worse, but the sly glances his fellow apprentices cast in his direction were full of fiendish glee. After telling Bob to "pull her to pieces and see what's the matter" the boss left Bob to work out his own salvation. Although he took the pump apart and examined every inch of it thoroughly, he could find nothing wrong, until he tried to look through the inlet pipe—he couldn't see light. Then Bob knew what the trouble was, and another leaf was added to his book of experience.

Back together went that pump in double-quick order, and this time it worked fine and to the satisfaction of the boss. Bob's detective abilities traced the stopper to the empty bottle in his shop-mate's dinner box, and it wasn't long before he was paid back in his own coin—but that's another story.

* * *

Aluminum paint is made by blowing air or gas through molten aluminum while it is setting, and at the same time stirring violently. This forms a spongy or granulated metal that is easily pulverized. The powdered metal is sized and polished in polishing mills.—*Mechanical World.*

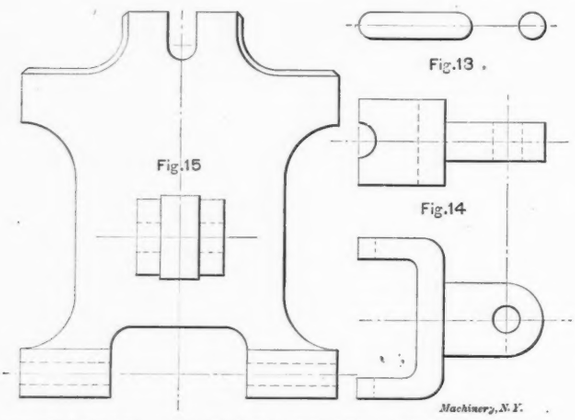


Standard Jig Design No. 4 for Manufacturing Small Interchangeable Parts. See next page

STANDARD DESIGNS OF JIGS AND FIXTURES FOR THE MANUFACTURE OF SMALL INTERCHANGEABLE PARTS—2

FRANK P. CROSBY*

In the July issue three designs of drill jigs were shown, indicating the possibility of standardizing the design of tools of this kind. In the accompanying illustrations are shown two additional jig designs, and dimensions are given for standard jig parts.



Detail of Upper Leaf and Equalizing Clamp, Jig Design No. 4

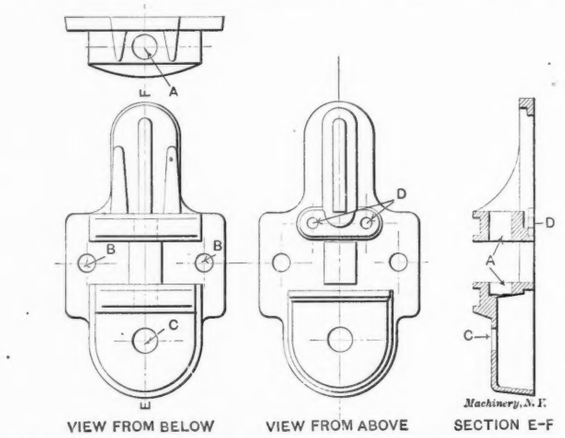
Design No. 4

The jig designated as Design No. 4 is used for drilling and hollow milling the piece shown in detail in Fig. 16. The holes *A*, *B* and *C* are drilled, and the projections *D* are hollow milled. Fig. 1 shows the assembled jig with the work in place. The work is of such a form that it necessitates an extra swinging plate *E* to hold the drill guide *F*. The top plate *G* holds the equalizing clamp *H* in position. This clamp is hinged at *K* to allow for any inequality in the castings. The lower swinging plate *E* is held in place by the latch *L*. The work is held in place by the pressure brought to bear upon it by the upper plate *G*, which is held in place by a latch which at its upper end is provided with a nut *M*. The head of a binding screw *N* forces the works against the V-block *O*, previous to closing the upper plate.

The various parts are plainly shown in detail. Fig. 4 is an end view of a half of the V-block showing the screw and dowel pin holes. Fig. 10 shows the lower plate with bushings, V-blocks and adjusting screw in position. Fig. 11 shows the lower leaf with its drill guide, and Fig. 15 shows the upper leaf to which the equalizing clamp is attached.

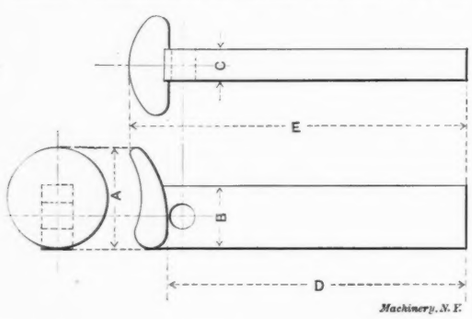
Design No. 5

The design of a drill jig for drilling and hollow milling the piece Fig. 11, Design No. 5 is shown in Fig. 1. This jig has double swinging plates the same as the previous one, but these plates both swing on the same pin. The equalizer *C* is mounted on the top of the top plate, and, as shown in Fig. 3, is provided with pins which run down and clamp the work at *D*, Fig. 1. The locating screw *E* brings the work into contact with the wall *A*, Fig. 7, and the screw *F* brings it into contact with the stop at *G*. The shoulder screw *H* prevents the lower plate from remaining down when the jig is open; the upper and lower leaves both must open simultaneously. The thumb screw *M* forces the lower plate firmly against the stop plugs *N*, Fig. 6, and prevents it from lifting during the operation of the mill. The upper leaf is finally clamped down by the swinging bolt *J*, provided with a knurled nut *K*.



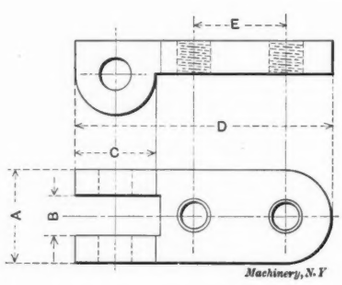
Work which is drilled and hollow milled in the Jig, Fig. 1, Design No. 4

TABLE I. DIMENSIONS OF THUMB LATCHES FOR JIGS



No.	1	2	3	4	5
A	1/2	3/4	7/8	1	
B	5/16	7/16	1/2	5/8	
C	1/8	5/16	1/4	5/16	
D	1 1/2	1 3/4	2	2 1/2	3
E	1 1/16	2	2 1/4	2 3/4	3 3/8

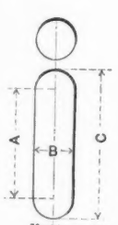
TABLE II. DIMENSIONS OF LATCH HOLDERS



No.	1	2	3	4	5	6
A	5/16	7/16	1/2	5/8	3/4	7/8
B	1/8	5/16	1/4	5/16	7/16	1/2
C	5/16	3/8	7/16	1/2	5/8	3/4
D	1	1 1/2	1 3/4	1 9/16	2 1/16	2 7/16
E	1/8	7/16	1/2	9/16	3/4	7/8

Fig. 7 shows the lower plate with its bushings and holding plugs in place, while Figs. 8 and 13 show the upper and lower plates or leaves. The other details are of the same standard form as used for the jig designs previously described.

TABLE III. DIMENSIONS OF LATCH HOLDER PINS



No.	1	2	3	4	5	6
A	5/16	7/16	1/2	5/8	3/4	7/8
B	3/16	1/4	5/16	3/8	1/4	5/16
C	5/16	3/8	7/16	1/2	1	1 3/16

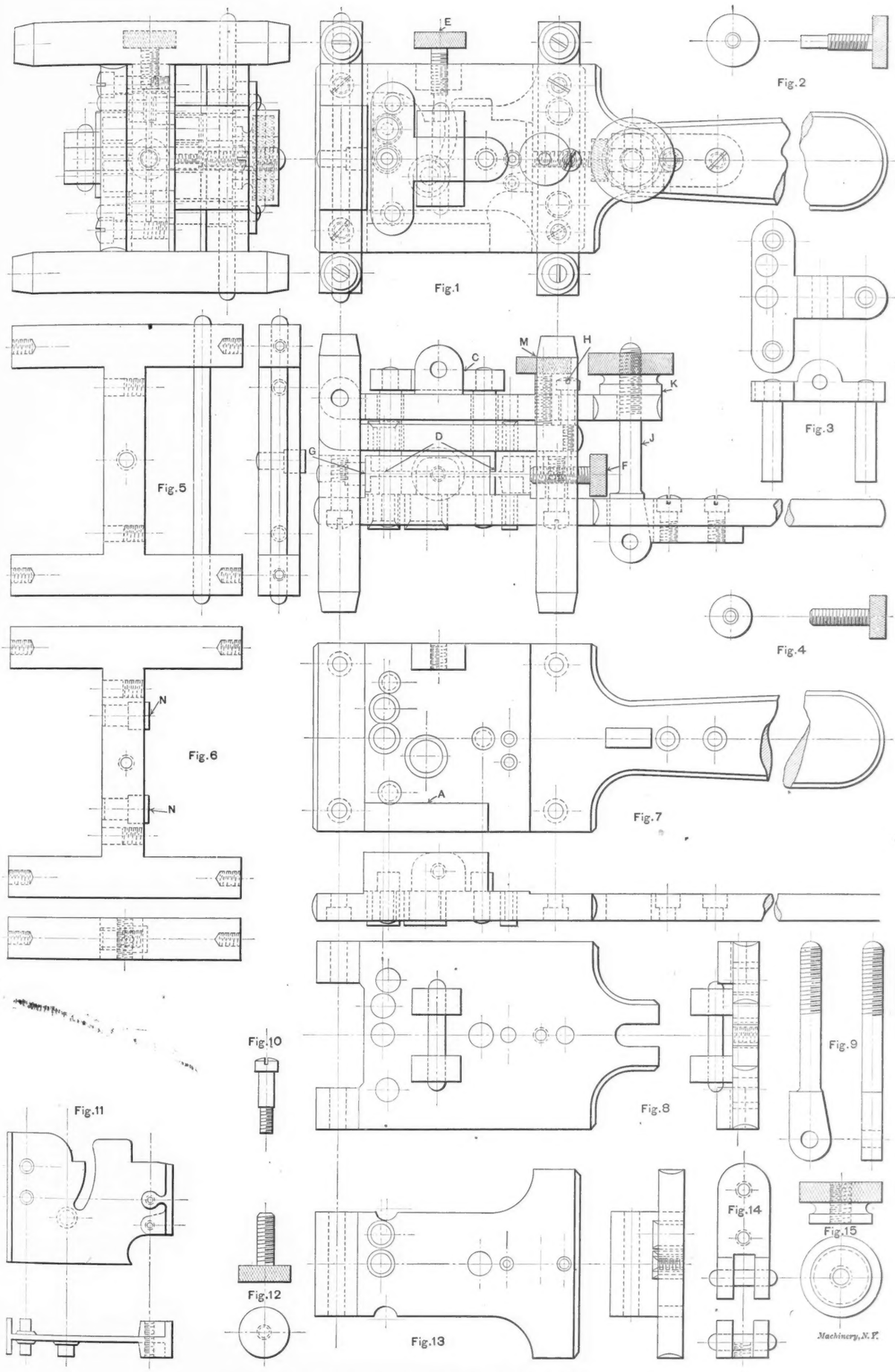
TABLE IV. DIMENSIONS OF LATCH PINS

No.	1	2	3	4	5
A	7/16	1/2	5/8	3/4	7/8
B	1/8	5/16	3/16	1/4	5/16
C	9/16	11/16	13/16	1	1 3/16

Standard Parts for Jigs

The accompanying tables give dimensions for a number of standard jig parts which can advantageously be kept in stock

* Address: 43 North State Street, Chicago, Ill.



Standard Jig Design No. 5 for Manufacturing Small Interchangeable Parts

ready for use. A great saving in the expense for jigs and fixtures will result if jigs are made up along the lines of the standard designs shown, and standard parts kept on hand, these parts being made up in quantities. Of course, it is understood that it may not be possible to adapt the jig details tabulated to all classes of work. The designer must make his own standard to suit the work on which he is employed, but the dimensions given have been found to work well on small interchangeable work, and the main point to be impressed upon the jig designer is that a system can be devised for standardizing the general design of jigs, as well as the details used.

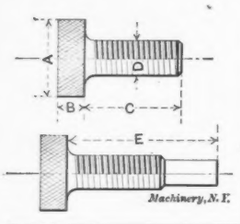
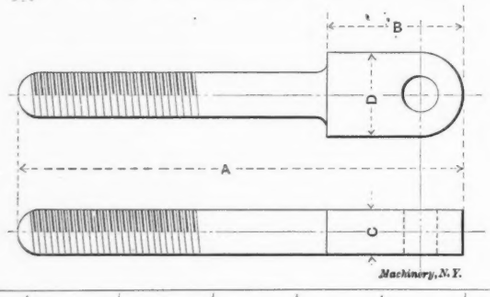


TABLE V. KNURLED HEAD THUMB SCREWS

No.	1	2	3	4	5	6
A	1/4	9/16	5/8	11/16	3/4	7/8
B	5/32	5/32	3/16	7/32	1/4	5/16
C	1/4	5/8	3/4	7/8	1	1 1/8
D	1/4	5/32	3/16	1/4	5/16	3/8
E	3/4	15/16	1 1/8	1 5/16	1 1/2	1 3/4

TABLE VI. DIMENSIONS OF JIG SCREW LATCHES



No.	1	2	3	4	5	6
A	1 1/4	1 3/4	2 3/4	2 7/8	3 1/2	4 1/8
B	3/8	5/8	3/4	1/2	1	1 1/4
C	1/4	3/8	9/16	1/2	5/16	3/8
D	5/16	3/8	7/16		5/8	3/4

But little is necessary to say in explanation of the tables. The latch holders in Table II should be made of machine steel, case-hardened and the pin hole lapped to fit the pin with a close sliding fit. The latch holder pins and the latch pins in Tables III and IV are made of tool steel and hardened. The knurled head thumb screws in Table V should only be used for clamping when a light pressure is required. The latch nuts in Table VII are made of machine steel and case-hardened. The pins in Table VIII are made of machine steel and left soft. The screws for the jig feet, Table X, are not standard screws. The diameter *A* is smaller than regular, and the length of the head is also less.

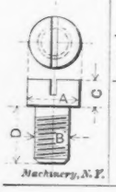


TABLE X. SCREWS FOR JIG FEET

No.	1	2	3	4	5	6	7	8	9
A	.160	.191	.213	.233	.256	.299	.343	.386	.426
B	1/8	9/64	5/32	11/64	3/16	7/32	1/4	9/32	5/16
C	.110	.123	.137	.150	.164	.192	.219	.246	.273
D	9/32	5/16	11/32	3/8	13/32	7/16	15/32	1/2	17/32

* * *

A correspondent to the *Pittsburg Dispatch* states that Hankow, China, possesses a large modern steel plant, employing, in all, 20,000 people, only twenty of whom are Europeans. The latter largely do the designing and engineering work, while the Chinese carry on the work in the steel mills and the shops entirely by themselves. The wages are very low; steel mill rollers are paid from $4 to $6 per month and helpers from $4 to $5. Blacksmiths are better paid, and receive up to $20 per month if exceptionally skilled, while boiler-makers may get up to $10. Common unskilled labor is paid 7½ cents a day. Unskilled men are paid off in full each night, and are hired anew each morning.

EFFECTIVE FLOATING REAMER HOLDER USED BY THE LANDIS TOOL CO.

Only in recent years has it been considered practicable to finish ream holes in the machine on which the hole is roughed out. It has always been the customary practice to bore and rough ream in the machine and finish ream by hand, holding the work in a vise or a special reaming stand. The difficulty in machine reaming has been that of properly holding the reamer so that it will cut from the side of the hole the infinitesimal amount desired. If the reamer is not held properly, either it will not finish the hole out, leaving the marks of the roughing reamer on one side, or it will dig in and break the blades or cause other damage.

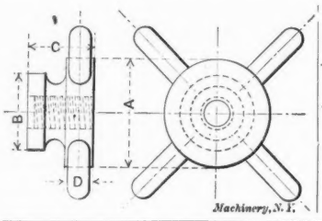
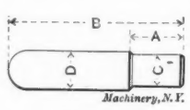


TABLE VII. DIMENSIONS OF LATCH NUTS

No.	1	2	3	4	5	6
A	5/8	3/4	7/8	1	1 1/8	1 1/4
B	7/16	1/2	9/16	5/8	3/4	7/8
C	5/16	3/8	7/16	1/2	9/16	5/8
D	5/32	5/32	3/16	3/16	1/4	5/16

TABLE VIII. LATCH NUT PINS



No.	1	2	3
A	7/32	1/4	5/16
B	11/16	7/8	1 1/8
C	3/32	5/32	5/16
D	1/8	3/16	1/4

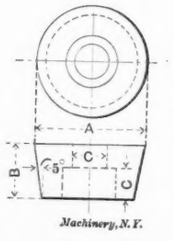


TABLE IX. STANDARD JIG FEET

No.	1	2	3	4	5	6	7	8	9
A	3/8	7/16	1/2	9/16	5/8	13/16	3/4	7/8	1
B	3/16	7/32	1/4	9/32	5/16	13/32	3/8	7/16	1/2
C	1/8	9/64	5/32	11/64	3/16	7/32	1/4	9/32	5/16

The problem of machine reaming is then one of devising a suitable reamer holder. This must be of the "floating type," so that the cutting edge is guided by the hole itself, otherwise it will not center itself properly with the rough reamed surface. About the best thing in this line the writer has previously seen is the holder used by the Bullard Machine Tool Co., in which the reamer is fed through the hole by a loose joint connection with the arbor near the front end of the body. The arbor itself is provided with a loose drive at the rear end, where it is connected with the holder in the turret. By pivoting the reamer body at the front end in this way, it is in effect *drawn* through the hole, which thus guides it in a way superior even to the best hand reaming. The holder

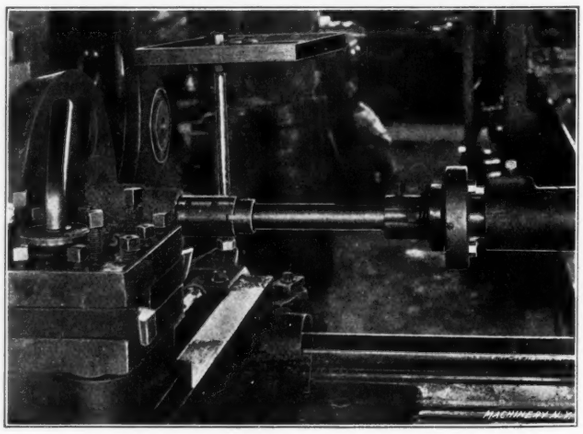


Fig. 1. Floating Reamer Holder for Turret Lathe Use, Guided by Adjustable Center

shown herewith was developed by Mr. Steiner, superintendent of the Landis Tool Co., of Waynesboro, Pa.; besides being of the floating type, it is so arranged that it can be used with reamers much smaller than in the design just described, adapting it to all kinds of work, both large and small.

The tool is shown at work in a Gisholt turret lathe in Fig. 1, while Fig. 2 shows a section of the holder and plainly illustrates its construction. The reamer at *A* is held in the taper socket *B*, which is, in turn, firmly threaded into the flange *C*. The body of the tool *D* is carried in a taper tool holder *E*, mounted in the turret of the machine. In a recess in *D* is contained the floating center holder *F*. Two screws *G* (only one of them is shown) are tapped into *F* from the back side of *D*, passing through holes large enough to allow a slight adjustment in any direction. With this provision center *H* may be accurately lined up with a similar, truly-ground center, mounted in the spindle of the machine. Four screws, of which one is shown at *K*, assist in this centering operation.

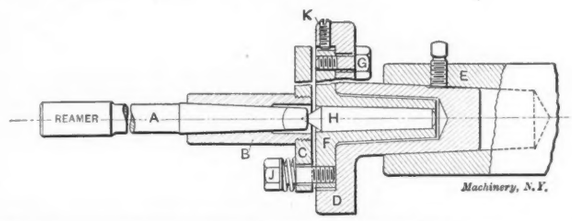


Fig. 2 Section through Reamer Holder, showing Details of Construction

When the two points are in line, screws *G* are tightened down, thus holding the adjustment. Reamer *A* has its center hole supported on the point of center *H*, being drawn onto it by two screws, of which one is shown at *J*. These screws pass through clearance holes in *C* and press upon it, through the medium of springs as shown, thus allowing reamer *A* to find its own center without interference.

Besides using reamers from the largest to the smallest sizes, as previously mentioned, this arrangement has the added advantage of straightening out the holes it reams, at the same time that it follows them. It is supported at the back on a center which has been adjusted concentric with the axis of the spindle, about which the work revolves and is supported. If the hole, in spite of the boring and rough reaming operations, is not quite parallel with the axis of rotation, the tendency of this reamer, supported on center *H* as it is, is to correct such slight errors, and bring the bore back into the proper center line. R. E. F.

* * *

HOW TO FIND INCLUDED ANGLE OF INLET AND EXHAUST CAMS

A. F. M.

Much has been written about the laying out of cams, but one reads little about the mathematical calculation of cams. The simple formula given below saves the designer the work of laying out the included angle of inlet and exhaust cams of gas engines. In laying out this angle some small inaccuracies very often occur, and it is, therefore, of special advantage to be able to calculate this angle; when desired, a layout can be used to check the result. The angle in question, shown at *c* in the illustration, necessarily must be correct, or a more or less incorrect opening and closing of the valves will result. Angle *a* represents the angle on the cam shaft, during which the valve is open. *R* and R_1 are the radii of the cam base circle and the cam roller, respectively, while *C* is the clearance between the plunger and valve stem. Then the distance between the center of the cam and the center of the roller at the moment of the opening of the valve equals $R + R_1 + C$. Assuming a line drawn from *N* parallel to *AB*, and extending *MB*, we get the right triangle *MNP*, in which

$$MN = R + R_1 + C \text{ and } MP = R + R_1.$$

Then,

$$\cos b = \frac{R + R_1}{R + R_1 + C} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

But $d = 90° - \frac{1}{2}a - b$, and $d = \frac{1}{2}c$; therefore $\frac{1}{2}c = 90° - \frac{1}{2}a - b$, and

$$c = 180° - a - 2b \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In case no clearance between cam and roller is allowed. Then $C = 0$, and

$$\cos b = \frac{R + R_1}{R + R_1 + 0} = 1, \text{ and } b = 0.$$

This value of *b* substituted in formula (2) gives:

$$c = 180° - a.$$

Suppose we want to find the value of angle *c* for an exhaust cam which should keep the valve open during 240 degrees, measured on the crank-shaft. This corresponds to 120 degrees on the cam circle. Let the base circle of said cam be 2 inches and the roller 1½ inch in diameter. The clearance is 1/16 inch. Then $a = 120$ degrees, $R = 1$ inch, $R_1 = \frac{3}{4}$ inch, $C = 1/16$ inch.

Substituting these values in formula (1) we get:

$$\cos b = \frac{1 + \frac{3}{4}}{1 + \frac{3}{4} + 1/16} = \frac{28}{29} = 0.9655; \quad b = 15 \text{ degrees } 5 \text{ minutes.}$$

Substituting this value of *b* in formula (2)

$$c = 180° - 120° - 30°\ 10' = 29 \text{ degrees } 50 \text{ minutes.}$$

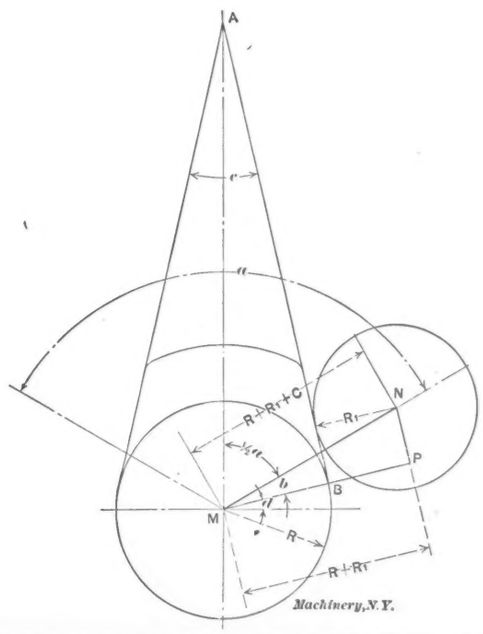


Diagram illustrating the Method of Calculating Included Angle of Inlet and Exhaust Cams

These formulas are correct only for a valve mechanism in which the center line of the valve plunger passes through the center of the cam shaft. In case the valve plunger is offset (to diminish side thrust), an irregular cam will result. This is mentioned only to avoid any possible misapplication of the formula.

* * *

As has been previously stated in these columns, extensive use will be made of blast furnace gases for power production at the new steel works at Gary, Ind. With the sixteen furnaces in operation it is estimated that 44,800,000 cubic feet of gas will be produced daily, and of this over one-half will be used for power generating purposes. Part of this will be required for the blowing engines and about 45 per cent of the total available gas will be used for power. With the sixteen furnaces in blast, it will be possible to generate in this way over 200,000 H. P.

* * *

According to the *Scientific American*, a new form of arc lamp has been devised in which carbon disks are used instead of carbon rods. The disks are constantly rotated, and the arc takes place between their peripheries; owing to the continuous rotation, the disks are consumed uniformly. The lamps are small as compared to the ordinary type of arc lamps, and it is claimed that a lamp of this type will burn fifty per cent longer than lamps of the rod type.

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AUGUST, 1909

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

CURVES VS. TABLES

The presentation of certain data in the form of curve diagrams, of the Cartesian coordinate form, is advantageous for several reasons. First, in a curve there may be an infinite number of intersections of ordinates and abscissae, and therefore of values within the limits of the diagram; whereas a table is limited to the precise values given, and interpolation in any but tables agreeing with straight line curves must of necessity be inaccurate unless calculated by the curve formula. Again, plotted curves clearly indicate the rate of change, and values plotted outside the limits of the diagram can be estimated or calculated with precision when the curve can be expressed by an equation. Hence, it is not strange that the plotting of curves is a common and generally acceptable method of graphically showing a great and varied mass of engineering data.

But we find curves used for data when they are not properly applicable to the case. When certain exact data have been determined and accepted, the use of curves for the drafting room or shop is not so desirable as ordinary tables. For example, take the case of pipe thread dimensions: these data were recently submitted to us in a diagram of curves, the contributor being under the impression, evidently, that the curves possess some advantages over the usual pipe thread table. Obviously, the reading of precise values, that is, to thousandths of an inch, is impossible on an ordinary diagram. A toolmaker given the job of making gages for pipe fittings would have absolutely no use for the diagram; what he needs is the table of precise values reading to thousandths. So it is with all screw tables and much other data in which all values of a series between limits have been precisely determined.

Curves have their use in the derivation of such data when a series of values are being tentatively determined. Having given the dimensions of the largest and smallest sizes, and perhaps of one or more intermediate sizes, a curve may be drawn and the other values approximately found without calculation. For illustration, suppose that a special list of thread pitches is to be laid out for certain fittings ranging in size from one inch to ten inches diameter, the sizes varying by half inches. Having given the data for the largest and smallest and one or more intermediate sizes, the curves drawn through the intersections with the ordinates and abscissae will express the intermediate pitches for each desired size. The approximate values will be changed, of course, in most cases to make them read to the nearest even figures. The values once having been determined and crystallized, so to speak, the use for the curves disappears.

* * *

THE PSYCHOLOGY OF MAGNIFIED DIMENSIONS

Not many years ago the micrometer was an unknown instrument of measurement, and is still comparatively unused outside of manufacturing plants producing parts on the interchangeable plan. The steel scale graduated in sixty-fourths of an inch is a gage by which the large majority of mechanics make all their measurements from the coarsest to the finest, and for most of them measurements made with the steel scale generally answer practical purposes. The machinist who is able to fit a locomotive axle or crank-pin, making the proper estimate for a press fit of 50 to 100 tons, depending on the diameter, by the use of outside and inside calipers, and gaging the allowances by the difference on a steel scale, has a "good eye" and good judgment.

While these measurements may vary slightly day by day, the average is surprisingly accurate and leaves little to be desired. But ordinarily it takes the common man several years before his fingers and eyes acquire the sensitiveness that makes his estimates uniformly reliable. Give the same man a micrometer, and under proper direction he will learn to make more accurate measurements in a few months than is possible with years of experience with the calipers and scale. The reason is simply magnification of differences. The ratio on the ordinary micrometer barrel is about sixty to one, thousandths of an inch between the anvils being about one-sixteenth inch on the barrel. An apparent difference of one-sixteenth inch from the measurement desired is an amount that even a tyro will not ignore when he knows how to use the micrometer, and realizes that it is an instrument of touch rather than a C-clamp.

The principle of magnification of small dimensions is common in the apparatus used in scientific and mechanical work, and is accepted by all users as a matter of course, but we suspect that most users of such instruments never quite realize the extent of the impression made by small values through this principle of magnifying them. A new pyrometer recently described in these columns carries the principle to an extreme, fractions of a degree of temperature difference being expressed by the needle swinging over a large portion of the visible arc of action. The effect of minute differences of temperature indications on the attendant when shown by so great a movement of the pointer is very marked. He cannot ignore, if he would by reason of ordinary slothfulness, differences that on an ordinary indicator would be almost imperceptible, and therefore negligible.

* * *

An interesting observation has been made in connection with tempering of hardened tools in electrically heated baths. It was found that the obtaining of a certain tempering color is not a function of the temperature only, but that time also is an important factor. As an example it may be mentioned that a dark blue was produced by heating an object either to 200 degrees C. (392 degrees F.) for four minutes, or to 350 degrees C. (662 degrees F.) for one minute. This statement was made in an exhaustive paper on electric hardening and tempering by Messrs. E. Sabersky and E. Adler, read before the Faraday Society (Great Britain), and if correct practically upsets the generally accepted idea that tempering colors are dependent solely on temperatures. Whether the color determines the degree of temper of the tool or not is not stated; most likely it does, but it might be conceived that the time factor influences the degree of temper also. Experiments along this line should be of great value, and may lead to a new conception of the tempering process.

CARRIAGE-BOLT SCREW THREADS

On the "How and Why" page of this number are certain data on carriage bolt screw threads, shanks, and heads, that doubtless will be of interest and value to a considerable number of tool- and die-makers, but for the screw thread part, we feel an apology is required. We do not mean an apology for our presentation of the matter, but for the existence of such an anomalous form. Carriage and loom bolts are used in great quantities, but strange to say, the screw threads as made by the largest concerns are bastard forms, not easily reproduced, and for which there is no commonly recognized standard. A few concerns using large quantities of carriage bolts specify the United States standard thread and pitches, and one maker at least recommends them, but why the demand for the recognized standard has not become universal is somewhat of a mystery. Perhaps the approximately square carriage-bolt thread has an advantage over the United States standard thread when driven through a closely fitted hole in wood, in not having so great a tendency to tear and damage the wood, but it is easily damaged and hard to repair. Other disadvantages outweigh the feature named, and it should have been discarded long ago.

The vogue of the carriage-bolt threads may be largely due to the conservative policy of manufacturers who have maintained them because of the mistaken belief that the obscure forms tend to discourage competition. Such a petty business principle is out of place in modern manufacturing, and is of little avail. A screw thread, gear tooth or profile of any description, no matter how irregular, can be copied by an expert tool-maker; such work is done daily, and an odd screw thread offers little discouragement to the copyist if there is assurance of profit. Let the irregular and difficult carriage screw threads be relegated to the limbo of forgotten things; and when they are discarded we shall score another triumph for standardization.

* * *

LOCATING DEFECTS IN MECHANISM

The ability to quickly locate defects in machinery is possessed by comparatively few men. Competent engineers and mechanics, having years of experience, often, when trouble is encountered, find it necessary to send for an "expert" to solve what appears to be a great mystery. In many instances, the real reason why engineers and others are unable to locate simple mechanical defects is because they at once jump at the conclusion that the trouble is due to something complex and mysterious. As every mechanic knows, the disarrangement of some small part will often render a piece of mechanism inoperative or greatly impair its efficiency; but as a rule the seat of the trouble can be located by a careful and systematic inspection. Such inspection however is often not made because of a sort of superstitious belief that any trouble which is unusual must be the result of something mysterious, and this belief is always augmented when attempts are made to locate the defect by haphazard methods. It is a common experience of men sent out by manufacturers to locate and remedy trouble in machinery to find simple causes —so simple sometimes as to make the call for help ridiculous.

The chief engineer of a large plant discovered, upon starting an air compressor which had been idle for some time, that it would only compress to twenty pounds, which was sixty pounds below the required pressure. After a few futile attempts had been made to remedy the trouble, the manufacturer was notified by wire to send an "expert." In order to appreciate the situation a brief description of the construction of the compressor is necessary. This machine had two single-acting air cylinders, the plungers of which were connected to the ends of a piston-rod common to both, which passed through the steam cylinder located midway between the two air cylinders. The inner ends of the air cylinders were open, exposing the plungers. One suction and one discharge valve was used for each cylinder. The suction valves were located in the centers of the plungers, and the discharge valves, which were slightly larger in diameter than the bore of the cylinders, covered the outer ends of the latter. The counterbore into the bottom of which each discharge valve seated, was sealed by the cylinder head. A cylindrical projection on the back of each discharge valve, was a sliding fit in the head, and served to keep the valve in position as it moved back and forth. In order to insure a pressure of one atmosphere in the cylinder at the beginning of the compression stroke, three small holes were drilled through the cylinder wall, just ahead of the plunger when it was in this position. As these holes were uncovered just before the end of the suction stroke, an inrush of air occurred, the magnitude of which depended largely upon the stiffness of the closing springs for the suction valves. When the manufacturer's "expert" arrived and the compressor was started, it was very noticeable that instead of an inrush of air through the holes of one cylinder, there was a strong discharge to which attention was attracted by the sound emitted. This indicated at once that the cylinder was in communication with the receiver, and it was also evident that the discharge valve was either broken or displaced. When examined it was found to be rusted fast to the head in an open position. Less than a thimble of oil jumped the pressure to eighty pounds, much to the discomfort of the chief engineer.

Still another incident from the log-book of a "trouble man" will be given to show how easy it is to overcome the cause of a defect when the search is conducted along intelligent lines. The suction valves of a high-pressure pump, working under a pressure of about 2,000 pounds per square inch, had given considerable trouble, evidently due to a leak through the valves on the discharge stroke, as then a sibilant sound could be heard, which was pretty good evidence. The leak, however, had not occurred until after a new set of valves made by one of the chief engineer's assistants had been installed, which added to the mystery, as the valves were carefully ground to a perfect bearing in their seats. These valves were of the poppet type, and on the top of each there was a guiding stem that was a sliding fit in a cap above. On the original valves the stems were fluted so that air would be admitted to the space above them. On the new valves these flutes were omitted, with the result that they closed so slowly, owing to the partial vacuum formed above the stems during their descent, that there was considerable discharge through them during the early part of the discharge stroke. In this particular instance a little elementary knowledge of physics was a greater help in discovering the trouble than practical mechanical training, and the incident teaches the value of acquiring knowledge other than that necessary to hold a position, for such knowledge is often the key to the door of opportunity. Of course the causes of defects in mechanism are not always so easily located, nor of such a simple nature as those mentioned in the foregoing, but experience teaches that work of this kind may be greatly facilitated by a careful and systematic inspection, after having observed any abnormal action.

* * *

In a paper on the preservation of iron and steel by Mr. Allerton S. Cushman, assistant director, office of public roads, United States Department of Agriculture, presented before the May meeting of the Iron and Steel Institute, the author refers to the fact that iron containing 20 per cent of silicon is not attacked by acids and, therefore, such material should theoretically be non-rustable. He has found that iron containing 10 per cent of silicon is almost incorrodible, but unfortunately is not easily worked, and has peculiar properties. He suggests that inasmuch as silicon is similar to carbon in its characteristics, chemically speaking, it might be worked into the surface of steel by modifying some of the well-known casehardening processes used for impregnating iron and steel with carbon. If a method for applying a coating of silicon on metals should be discovered, it would be a valuable contribution to the art of metallurgy and the world at large.

* * *

According to the *Engineering Record*, an interesting means of heating a building will be tried at Detroit, Mich. The hot water from the jackets of a 1,400-horse-power gas engine now being built for the Ford Motor Co. will be utilized for this purpose.

THE TRANSMISSION OF POWER BY ROPES*

When compared with belts, ropes have some very distinct advantages, the most important being that they slip less and that the drive is more positive. As the rope acts in a groove, the loss due to the centrifugal force is lessened as compared with belt driving, and ropes can therefore be run at a higher velocity than belts. While few cases of rope transmission exceed a velocity of 5,000 feet per minute, there are cases of ropes running satisfactorily on specially constructed pulleys at a speed of over 7,000 feet per minute. The accompanying table gives the horse-power which may be safely transmitted by cotton ropes of different diameters at various speeds. Ample, though not extravagant, margins of safety against breakage of individual ropes are provided, and the table applies to the average good quality of rope, giving to superior makes the benefit of greater durability. With regard to the relative cost of ropes and belts, experience has shown the former to be cheaper; this advantage is more marked in the case of small ropes than in the case of larger sizes.

Rope driving may be divided into two systems, known as the American or continuous system, and the English or multiple rope system.

The Continuous Rope System.—The continuous or American rope system consists of winding one long rope as many times around the driving and driven pulleys as there are grooves to fill, carrying the rope across the whole width of both pulleys and then carrying the rope from the last groove back again to the first groove by means of an idler pulley

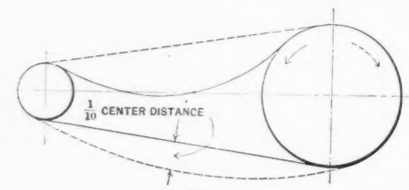


Fig. 1

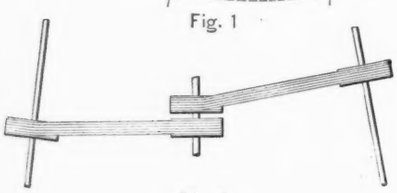


Fig. 2

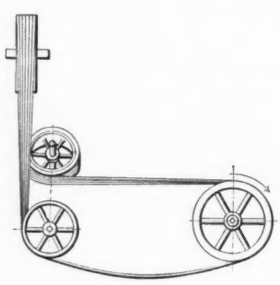


Fig. 3

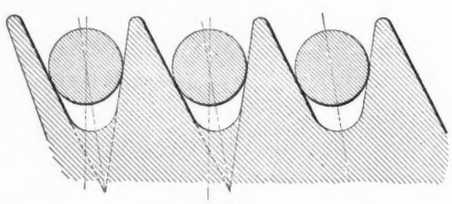


Fig. 4

Fig. 5

Figs. 1 to 3. Power Transmission by Ropes. Figs. 4 and 5. Tilted Grooves for Angular Drives and Arrangement of Drive for Crossed Ropes

held at the required angle. This system possesses certain advantages under special conditions, as, for instance, when driving paper-making machinery by a series of expanding rope pulleys so arranged as to permit a variation of a few inches in the respective diameters. Under ordinary conditions, however, the comparative imperfections of the method are so pronounced that numerous installations have been transformed to multiple rope drive. A great disadvantage of continuous driving is that of having to depend upon one rope for the entire drive, and the resulting stoppage of the machine in the event of breakage. In case of multiple driving, an accident to one of the ropes means only running without it for the remainder of the day, as a good reserve of power is generally allowed in the remaining ropes.

Another objectionable feature of continuous driving is the irregular rope tension. The trailing span reaches its highest tension immediately after leaving the idler pulley and gradually slackens down with each successive lap of the pulleys.

Casing of Pulleys.—It is important when arranging for rope driving to encase the sides of the pulleys with sheet metal or boards, as otherwise the displacement of air by the arms of large high-speed pulleys adds materially to the load. It has been stated that a saving of five per cent of the power may be thus effected. Some firms advocate the casing of all pulleys, large or small, while others do not consider casing necessary unless the pulleys be at least seven feet in diameter and run at a peripheral velocity of 4,000 feet and over.

Minimum Diameter of Smallest Pulley.—For ordinary cotton ropes used as main driving ropes the smallest pulley diameter should be thirty times the diameter of the rope. If this rule is adhered to the rope will cling firmly to the pulley.

Durability of Ropes on Large and Small Circumferences.—Too much importance cannot be attached to the question of relative proportion of pulleys and ropes, and great losses in driving power are caused by non-observance of the "thirty-diameter" rule. Instead of adding a number of heavy ropes to make up for the loss of power transmitted, when large pulleys are impractical, it is far better to divide the total power nominally required between the necessary number of smaller ropes.

Arc of Contact.—When the pulleys are of equal size the arc of contact of each is practically 180 degrees, but when the pulleys are of an unequal size the arc of contact of the smaller pulley is less than 180 degrees. Long center distances, however, are conducive to a greater degree of contact for the smaller pulley, and whenever short center distances can be avoided it is advisable to do so. When short centers are required, the disadvantages can be overcome by adding a sufficient number of ropes to make up for the deficient contact, and a case is on record where spur gears were removed from two shafts and rope pulleys fixed upon the same centers, permitting a clearance of only eight inches between the rims, 360 horse-power being thus easily transmitted with sixteen ropes, 1¾ inch in diameter. In another case two rope pulleys were placed so close together that there was less than an inch distance between the outside of the rims.

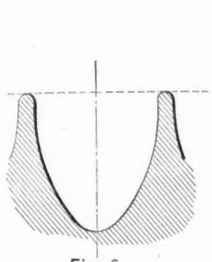
The arc of contact is also affected by the position occupied by the trailing span of the ropes which, when above the pulleys, gives the maximum bearing surface. This position, however, is not always obtainable, as sometimes a variable load may set up oscillations in the rope of such violence as to fling it off the pulley. In this case, if the trailing span is below the pulleys, any tendency on the part of the rope to wander from its appointed track is held in check by the pull at the tight side.

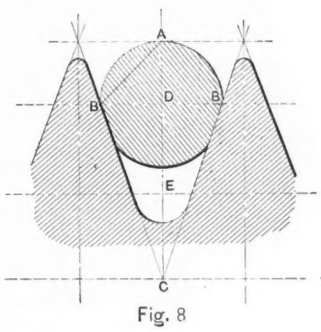
Long Center Distances.—Referring to Fig. 1, it will be observed that in under-driven installations, center distances are governed by the size of pulleys employed, which should allow sufficient clearance between the slack of the trailing span (which should be not more than 1/10 of the distance between the centers) and the tight portion of the ropes. Over-driven installations permit a greater latitude, and center distances are successfully extended to distances of over 100 feet without intermediate support. In drives of this kind, however, it is necessary to provide against the extra strain imposed on shafts and bearing by the weight of the ropes. Center distances in ordinary mill driving seldom exceed 90 feet. As a rule, it is preferable to divide distances which are too great for one span into two drives, rather than merely to support the ropes between the pulleys by idlers. In cases where supporting pulleys are necessary, it is advisable to distribute them along the drive at unequal intervals. The possibility of continued oscillations along the whole track

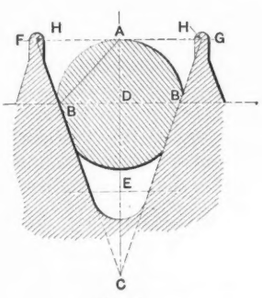
* Abstract of paper read by Mr. Edwin Kenyon before the South Wales Institute of Engineers. For additional information on this and kindred subjects see the following articles previously published in MACHINERY: Rope Drive for Machine Tools, October, 1907, engineering edition; Notes on Rope Drives, January, 1908, engineering edition; Experiments with Rope and Belt Drives, February, 1909.

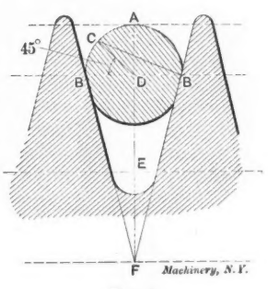
is thereby obviated, so that initial wave-like movements quickly diminish to small oscillations. This prevents the ropes from leaping out of the grooves.

Angular Driving.—No class of power transmission lends itself better to angular driving and drives around corners than does rope driving. When transmitting power to shafts set in an angular position, the tight side of the rope should be directed by a pulley deflected to a suitable angle, while the slack side of the rope should be carried over an idler revolving on a horizontal axis, as indicated in Fig. 3. The grooves in guide pulleys require to be turned deeper than in the regular pulleys, to prevent the ropes from falling away. As a rule, guide pulleys are made too small for the ropes passing over them, and as a result the ropes suffer considerably from over-straining in passing over sharp bends. The wear of ropes is due more to the bending than to the driving strain, and the "thirty-diameter" rule should be applied to idler pulleys as well as to the driving and driven pulleys.









Figs. 6 to 9. Grooves for Rope Pulleys

Shafts Slightly Out of Alignment.—When shafts are only slightly out of alignment, the ropes will direct themselves without the aid of guide pulleys, but the extent to which the angularity may be carried depends largely upon the center distances and the pulley diameters. With center distances not less than three times the average diameter of the pulleys, a deflection of seven degrees is safe. Sometimes an angle too large for direct drive may be divided up into two drives by the introduction of an intermediate shaft and pulleys, as shown in Fig. 2. Tilted grooves, as shown in Fig. 4, are advantageous for out-of-parallel driving because of aiding the rope to "catch on" and slide down the side having the greatest inclination from the vertical until it reaches the true driving position. The tilted groove, however, has its disadvantages; the pressure becomes one-sided and even impact is impossible. Wide-angled and highly finished grooves appear to be the best solution for this class of driving. Long keyways cut on both shafts are a decided advantage in the arrangement of angle drives, as they permit the movement of the pulleys to their most effective working position, which may be discovered only by practical tests.

Driving with Crossed Ropes.—When it is necessary to transmit power between shafts revolving in opposite directions by crossed ropes, the friction at the crossing point can be materially lessened by running the ropes in pairs, the two tight portions running together while the slack portions pass with slight pressure on the outside as indicated diagrammatically in Fig. 5, where the full circles show the tight parts and the dotted circles indicate the slack parts of the rope passing on the outside of the tight parts at the crossing point. If more than two ropes are employed, it is, of course, necessary to allow sufficient space between the various pairs of ropes to permit free passage of their trailing spans. Therefore, a crossed drive with four ropes will require six grooves, as shown in Fig. 5. One-half crossed rope drives are arranged on practically the same lines as one-half crossed belt drives; that is, the leading side follows a straight line from pulley to pulley, while the other side is drawn away at an angle governed by the relation of the center distances to the pulley diameters.

Vertical Drives.—In vertical drives it is advisable to have the ropes running without much slack, particularly if the bottom pulley happens to be the smallest, and to use fairly acute angles not exceeding 40 degrees for the grooves.

Grooves.—Grooves with curved sides, as shown in Fig. 6, have proved to be of no advantage, but on the contrary to result in loss of power, and should, therefore, be discouraged. These grooves are conducive to a rolling action of the rope in the groove, which is not always avoided even in straight-sided grooves, except if their angle is fairly acute. For this reason an included angle of not more than 40 degrees is recommended. It is estimated that the life of a rope is reduced by at least one-third when revolving in the groove.

In general, it may be said that the groove with a 40-degree included angle, as shown in Fig. 7, is the best for ropes above 1¼ inch in diameter, and a 30-degree groove, as shown in Fig. 9, is preferable for ropes below that size. However, for ropes of very small diameter, say ½ inch in diameter and less, used for driving cotton machinery, the included angle may be as acute as 15 degrees. Care should be used never to make the grooves too shallow, remembering the rope will not merely be tangent to the sides of the groove, but will take a wedge-shaped form and thus press itself down toward the bottom of the groove. In Fig. 7 flanges are shown at *F* and *G*, but as flanges of this character do not contribute in any way to facilitate but rather to prevent the rope falling directly in its working position when the driving is unsteady, many rope pulleys are laid out with flangeless grooves, as shown in Fig. 8. Grooves for idler pulleys, having no power to transmit, may be so constructed that the rope rests at the bottom of the groove so that as small an amount of power as possible is lost in passing over the pulley.

TABLE OF HORSE-POWER TRANSMITTED BY THREE-STRAND COTTON DRIVING-ROPES RUNNING ON PULLEYS NOT LESS THAN THIRTY TIMES THE ROPE DIAMETERS

Rope Diameters	1"	1¼"	1½"	1⅝"	1¾"	1⅞"	2"	2¼"	2½"
Minimum Diameter of Smallest Pulley	2' 6"	2' 10"	3' 2"	3' 5"	3' 9"	4' 1"	4' 5"	4' 9"	5'
Velocity in Feet per Min.									
1000	3.3	4.1	5.1	6.1	7.4	8.6	10	11.5	13.0
1100	3.6	4.5	5.6	6.7	8.1	9.5	11	12.6	14.3
1200	3.9	4.9	6.1	7.3	8.9	10.3	12	13.8	15.6
1300	4.2	5.3	6.6	8.0	9.7	11.2	13	14.9	16.9
1400	4.6	5.7	7.1	8.6	10.4	12.0	14	16.0	18.3
1500	4.9	6.1	7.6	9.2	11.1	12.9	15	17.2	19.6
1600	5.2	6.6	8.1	9.8	11.9	13.8	16	18.4	20.9
1700	5.5	7.0	8.6	10.4	12.6	14.6	17	19.5	22.2
1800	5.8	7.4	9.1	11.0	13.4	15.5	18	20.7	23.5
1900	6.2	7.8	9.6	11.6	14.1	16.3	19	21.8	24.8
2000	6.5	8.2	10.1	12.2	14.9	17.2	20	22.9	26.1
2200	7.1	9.0	11.1	13.4	16.3	18.9	22	25.3	28.7
2400	7.8	9.9	12.1	14.7	17.8	20.7	24	27.6	31.3
2600	8.4	10.7	13.1	15.9	19.2	22.4	26	29.9	33.9
2800	9.1	11.5	14.1	17.1	20.8	24.1	28	32.2	36.5
3000	9.7	12.3	15.1	18.3	22.3	25.8	30	34.5	39.1
3200	10.4	13.2	16.2	19.6	23.8	27.6	32	36.8	41.8
3400	11.0	14.0	17.2	20.8	25.3	29.3	34	39.1	44.4
3600	11.7	14.8	18.2	22.0	26.7	31.0	36	41.4	47.0
3800	12.3	15.6	19.2	23.2	28.2	32.7	38	43.7	49.6
4000	13.0	16.4	20.2	24.5	29.7	34.5	40	46.0	52.2
4500	14.6	18.5	22.7	27.5	33.4	38.8	45	51.7	58.7
5000	16.2	20.6	25.3	30.6	37.1	43.1	50	57.5	65.3
5500	17.8	22.6	27.8	33.6	40.9	47.4	55	63.2	71.8
6000	19.5	24.7	30.3	36.7	44.6	51.7	60	69.0	78.3
6500	21.1	26.8	32.9	39.8	48.3	56.0	65	74.7	84.9
7000	22.7	28.8	35.4	42.8	52.0	60.3	70	80.5	91.4

Laying out a Groove of Approximately 40-degree Included Angle.—In Fig. 7 a circle is shown representing a section of the rope pressed into the groove so that the points *BB* of the

half circle *BAB* touch the sides of the groove. When laying out the groove, draw first the center line *BB*, and then the center line *AC* at right angles to *BB*. Then connect *A* and *B* and set off the length *AB* from the center *D* to *E*, which is the center of the circular section at the bottom of the groove. From *E* set off *EC* equal to *AB*, and draw lines from *C* through the points *BB*. These lines indicate the sides of the groove; their intersections with the line *FAG*, which is tangent to the top of the rope, mark the centers *HH* of the top of the flanges. The flangeless grooves shown in Fig. 8 are laid out in the same manner as the flanged grooves in Fig. 7, except that the sides of the groove are continued to sharp corners at the top, and then slightly rounded off as shown.

The 30-degree groove in Fig. 9 is laid out approximately in the following manner: Draw from the center *D* a line at forty-five degrees angle to the line *BB*, until it intersects the periphery at *C*. Connect *C* and *B* and set off the distance *BC* from *D* to *E* and the same distance from *E* to *F*. The point *E* is the center of the circular section at the bottom of the groove, and the lines *FB* give the sides of the groove.

Cotton Versus Manila Ropes.—In selecting the ropes for the drives, too much stress should not be laid upon initial cost, for although cotton is more expensive than manila, its superior qualities as a driving rope make it possible to transmit at least one-third more power with cotton ropes of the same diameter; besides, cotton ropes will wear approximately three times as long as manila ropes, and in some case considerably longer. The life of cotton ropes, of course, depends upon their size and the conditions under which they work. The most economical diameters range from 1½ inch to 1¾ inch, the last size being most commonly used for transmitting large powers. In a specific case twenty-four cotton ropes, 1¾ inch in diameter, are employed to transmit 820 horse-power at a velocity of 4,400 feet direct from the engine flywheel, which is twenty-eight feet in diameter, to the various rooms in a cotton mill. This installation was completed in September, 1878, and all the ropes driving one of the departments have been running until the present time, a period of over thirty years, without any attention more than tightening two of the ropes which accidently were saturated with water. Another set of cotton ropes has been working an average of twenty hours a day since April, 1885, and appears almost as good as new.

The three-strand rope is superior to the four-strand rope, and it is possible to transmit the same power with a fewer number of ropes when the three-strand rope is used.

Lubrication of Driving Ropes.—The chief function of lubricating material, as supplied to cotton driving ropes, is that of providing a smooth, filmy coating to prevent friction between the twisted surfaces of the strands in contact with each other. Re-lubrication is seldom necessary unless the ropes are working in an unusually dry atmosphere, and should even then be only sparingly used at long intervals. The most serviceable lubricant is compounded from saponified tallow, wax and plumbago, which sets hard like domestic soap. Greasy compounds likely to penetrate the fibers should be avoided as they increase the tendency to slipping. If ropes have been so treated, a liberal application of whiting is usually recommended, which absorbs the grease and falls away in flakes.

* * *

EFFICIENCY OF WATER WHEELS

Speaking of the methods employed in his practice, Mr. Charles T. Main, mill engineer and architect of Boston, says: "Some tests of water wheels show a maximum efficiency of about 85 per cent. It is probable that over 80 per cent is rarely realized in practice after wheels have been installed for a short time, and this is for three-quarters to full-gate opening. When the gate opening is less than about three-quarters, the efficiency begins to drop. After wheels have been run for some time the buckets and guides are not as smooth as when they are new, and the efficiency drops off. For these reasons I usually allow an average efficiency, for wheels running under ordinary conditions of age, repair, and variable gate opening, of about 75 per cent. Under exceptionally good conditions and where there are several wheels this could be increased."

SIMPLE METHOD OF STACK DESIGN*

A. J. HAIRE, JR.†

The engineer with a chimney or stack to erect, knowing the conditions he must meet with regard to boiler horse-power, draft, coal consumption, etc., usually turns to the hand-books, boilermaker's catalogues, and similar literature, rather than to one of the many exhaustive treatises we have on the subject of stack design. These catalogues and hand-books are often inadequate, treating the subject either so simply as to be incomplete, or so technically as to be practically useless. Matter that is found in one is often repeated in the others, and nine out of ten reproduce the familiar table that Kent worked out originally for his hand-book on mechanical engineering. All of these catalogues, however, are of some value, but nearly all fail in one respect or another to satisfy the needs of the busy engineer, who is not interested in learning the whole theory of the design, but wants definite information on how to build his stack with the conditions he has, so that it will work out as he wants it to after it is built. Ninety-nine times out of a hundred such an engineer decides on Kent's rule, and lets it go at that. Any values between those given in the table, he disregards, and, for any rate of coal combustion, or for any draft conditions other than those in the table, his percentage of errors is more or less great. He may overlook the fact that the values given by the table are based on a coal consumption of five pounds per hour, which is rather a high figure, and a figure that the average power plant should cut down materially with even a fair grade of coal and boilers loaded economically. He may also overlook, and generally does, that the draft figured in reaching the values of the table is presumed to be the best, a state of affairs not always found in the average station. If he does not use this table, making allowances for the differences between his conditions and those for which the table was drawn, he has to resort to the literature on stack design, and make a lengthy computation, and the chances for error will be twice as great as if he used the table.

The diagrams in the Data Sheet Supplement represent the medium between relying solely on a table drawn up for an arbitrary set of conditions, and making a separate design with great waste of time and possibility of error for each stack. Exact results can be obtained from them with ease and quickness. Every element that would come in any computation is met in these diagrams, as a glance will show, and there is absolutely no guesswork in any decision, no necessity for interpolation of values as in the case of the table, and no need of using constants to correct the final answer to suit your own case.

Use of the Diagrams

Diagram No. I, in the accompanying Supplement, gives a double set of curves which are plotted between temperatures of flue gas, or inside and outside air, with varying heights of stacks, and the draft pressure in inches of water. By it we can determine the relation of the height to the draft pressure desired with the different temperature changes. This diagram can also be used in determining the draft if we know the height of the stack and the temperatures of the inside and outside air.

Diagrams Nos. II and III show the relation between the height of stack, the amount of boiler horse-power, and the cross-sectional area. Diagram No. II provides for boiler horse-power up to 850, and No. III for values beyond that. Knowing the height, from Diagram No. I, and knowing the horse-power, we use these curves to get the effective cross-sectional area necessary for the stack.

Diagram No. IV makes it possible to determine at a glance the side of square stack having the necessary cross-sectional area, or the corresponding diameter of a round stack.

For example, we will design a stack for 2,000 boiler horse-power, stack temperature to be 550 degrees F. and outside temperature 80 degrees F., the maximum summer temperature. The pressure on the stack is to be one inch pressure of water. From Diagram No. I, starting at 550 degrees F. at the right of the sheet, run over to the curve representing 80 degrees F.,

* With Data Sheet Supplement.

† Address: 8638 Twentieth Ave., Brooklyn, N. Y.

temperature of outside air. From this point drop down to the horizontal line representing one inch pressure for the desired stack, in inches of water. The point found here gives us 160 feet for the stack height. Refer to Diagram No. III to find the cross-sectional area, since the boiler horse-power equals 2,000. Where the vertical line at 2,000 boiler horse-power crosses the line of the 160-foot stack, we get a point which, projected to the left of the sheet, gives a cross-sectional area of about 47 square feet. From Diagram No. IV we find the value of 47 square feet cross-sectional area on the curve, and running to the left we get the diameter of the stack corresponding to that area, which is 96 inches, or 8 feet. The side of the square stack with corresponding area as shown to the right of the diagram would be slightly less than 7 feet square. Hence, from the curves we have a stack 160 feet high, effective cross-sectional area of 47 square feet, and either 8 feet in diameter or 7 feet square.

These curves have been carefully worked out, and are exact. They are now in use by some of the largest engineering concerns in New York, and several universities have adopted them in their courses of instruction for power station work. The engineer who gives them a fair trial will undoubtedly find them of great value and superior to all general tables or arbitrary rules in the current literature or catalogues of the day.

* * *

METHODS OF TESTING THE HARDNESS OF METALS*

Few properties of iron and steel are of more importance than that of hardness. In some cases, as with a cutting tool or a pressure die, the metal is practically valueless unless it can retain a sharp edge; while in other instances, where the material has to be machined or cut and trued to shape, even a relatively slight increase of hardness is the cause of much inconvenience and expense. In a third class of material a good wearing surface is of prime importance; while, lastly, hardness may often serve as an indication of a degree of brittleness and untrustworthiness which might perhaps be otherwise unsuspected.

Hardness may be defined as the property of resisting penetration, and, conversely, a hard body is one which, under suitable conditions, readily penetrates a softer material. There are, however, in metals various kinds or manifestations of hardness according to the form of stress to which the metal may be subjected. These include tensile hardness, cutting hardness, abrasion hardness, and elastic hardness; doubtless other varieties could also be recognized when the experimental conditions are modified so as to bring into operation properties of the material in addition to that of simple, or what may be conveniently called mineralogical hardness. This has been defined by Dana as "the resistance offered by a smooth surface to abrasion." The usual quantitative tests for hardness are static in character, but the conditions are profoundly modified when the penetrating body is moving with greater or less velocity. The resistance to the action of running water, to the effect of a sand-blast, or to the result of the pounding of a heavy locomotive on a steel rail, afford examples of what might perhaps for purposes of distinction be called dynamic hardness, which is a branch of the subject which has received little examination.

Comparison will be made in the following of four typical methods of measuring hardness. Those selected include the sclerometer, introduced by the author in 1886; the scleroscope, recently invented by Shore; the form of indentation test adopted by Brinell about ten years ago; and the drill test introduced by Keep a few years earlier. Each of these methods has been used in actual works practice, and by various persons other than the inventor, and may thus be regarded as being typical of the particular class of test to which it belongs. Among the many other forms of test the microsclerometer and wearing tests call for special mention, though to these only incidental reference can be made.

* Abstract of paper read before the Iron and Steel Institute (Great Britain), May 14, 1909, by Prof. Thomas Turner, of the University of Birmingham. For additional articles previously published in MACHINERY see "The Brinell Method of Testing the Hardness of Metals," September, 1908, engineering edition; "A New Mechanical Test for Hardness," October, 1908, engineering edition.

The principles underlying the four methods selected for comparison may be briefly described as follows:

Turner's Sclerometer

In this form of test a weighted diamond point is drawn, once forward and once backward, over the smooth surface of the material to be tested. The hardness number is the weight in grammes required to produce a standard scratch. The scratch selected is one which is just visible to the naked eye as a dark line on a bright reflecting surface. It is also the scratch which can just be felt with the edge of a quill when the latter is drawn over the smooth surface at right angles to a series of such scratches produced by regularly increasing weights.

Shore's Scleroscope

In this instrument a small cylinder of steel, with a hardened point, is allowed to fall upon the smooth surface of the metal to be tested, and the height of the rebound of the hammer is taken as the measure of hardness. The hammer weighs

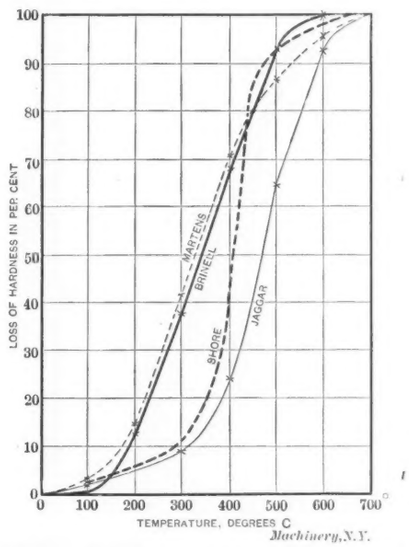


Diagram showing Percentage of Loss of Hardness of Hardened Steel when tempered to Various Temperatures, as measured by Different Hardness Testing Apparatus

slightly over 2 grammes, the height of the rebound of hardened steel is in the neighborhood of 100 on the scale, or about 160 millimeters, while the total fall is about 10 inches or 255 millimeters.

Brinell's Test

In this method a hardened steel ball is pressed into the smooth surface of the metal so as to make an indentation of a size such as can be conveniently measured under the microscope. The spherical area of the indentation being calculated, and the weight being known, the stress per unit of area when the ball came to rest is calculated, and this gives the hardness number. Within certain limits the value obtained is independent of the size of the ball, and of the amount of pressure. In the original tests the steel ball was 10 millimeters in diameter, and the pressure was equal to a weight of 3,000 kilogrammes; but a more convenient form of apparatus is now supplied by Mr. Brinell for works tests, while Mr. Stead has introduced a small and portable instrument.

Keep's Test

In this form of apparatus a standard steel drill is caused to make a definite number of revolutions while it is pressed with standard force against the specimen to be tested. The hardness is automatically recorded on a diagram on which a dead soft material gives a horizontal line, while a material as hard as the drill itself gives a vertical line, intermediate hardness being represented by the corresponding angle between 0 and 90 degrees.

Each form of test has its advantages and its limitations. The sclerometer is cheap, portable, and easily applied, but it is not applicable to materials which do not possess a fairly smooth reflecting surface, and the standard scratch is only definitely recognized after some experience. The Shore test is simple, rapid, and definite for materials for which it is

suited, and appears likely to have an important future. But further information is yet needed as to the exact property which is measured by this form of test. As shown by De Fréminville, the result obtained varies somewhat with the size and thickness of the sample, while if the test-piece is supported on a soft material, such as a plasticine, the results are valueless. It should also be pointed out that india-rubber gives a rebound of 23, which is equal to that of mild steel, while light soft pine wood gives a rebound of 40, which is nearly twice as great as that of gray cast iron. Curiously enough, hard wood, like teak, gives a rebound of about 12, while some samples are considerably lower than this. As illustrating the influence of the support, a sample of exceptionally hard rolled copper, about 1/25 inch in thickness, when supported on a block of hard steel, and tested with the blunt or "magnified" hammer supplied, gave a value of 30, which was increased to 34 when the copper was supported on wood. A sample of brass only gave a value of 17, and yet this brass would scratch the copper, while the copper would not scratch the brass. From these results it is evident that the Shore test is only applicable to a certain class of substances. It appears to test what may be termed the "elastic hardness," and gives high results with metals in the "worked hard" condition. Tests appear to show that good results are, however, obtained with glass and with porcelain, as well, of course, as with most metals.

The Brinell test is specially useful for constructive material; it is easily applied and definite, and is now of all hardness tests the one most employed. It appears to give satisfactory results with wood, but cannot be applied to very brittle materials, such as glass, or to hard minerals. Keep's test is specially suited for castings of all kinds, as it records not merely the surface hardness, but also that of the whole thickness, and gives indications of blowholes, hard streaks, and spongy places. Obviously, it can only be applied to materials the hardness of which is less than that of hardened steel.

A very important question arises in connection with these various tests—namely, as to whether there is any observed agreement between the results which are arrived at by such entirely different methods. It will be noticed that in each case an arbitrary scale is adopted. If the weights used on the

TABLE I. HARDNESS SCALES COMPARED

Metal	Sclerometer	Scleroscope	Brinell
Lead	1.0	1.0	1.0
Tin	2.5	3.0	2.5
Zinc	6.0	7.0	7.5
Copper, soft	8.0	8.0	....
Copper, hard	....	12.0	12.0
Softest iron	15.0	....	14.5
Mild steel	21.0	22.0	16–24
Soft cast iron	21–24	24.0	24.0
Rail steel	24.0	27.0	26–35
Hard cast iron	36.0	40.0	35.0
Hard white iron	72.0	70.0	75.0
Hardened steel	....	95.0	93.0

sclerometer had been ounces instead of grammes, the hardness numbers would naturally have been different. Similarly, Brinell's tests might have been expressed in tons and inches, or a different weight of hammer and height of scale adopted by Shore. Hence all that can be expected is a proportionality in the results, and if this is ascertained it should be possible to convert values on one scale into results on another.

An examination of results obtained by the four methods dealt with shows that, for relatively pure metals in their cast or normal condition, there is a general agreement which must be regarded as remarkable. In Table I will be found, in the first column, results which were published in the author's original paper on the hardness of metals in 1886. In the second column are the author's results with the Shore scleroscope, and these figures are in good agreement with those supplied by the maker of the instrument. In the third column are values taken from published results by Mr. Brinell and by Mr. Stead, but the numbers given have been divided by 6, as this figure has been found to suitably reduce the Brinell hardness values for purposes of comparison. It will be observed that either by accident or design the scale adopted for the scleroscope is, for practical purposes, identical with that of the sclerometer, while Mr. Brinell's values are proportional. The angles in Keep's tests are, or could easily be made, in pretty close agreement with the other values. It would therefore appear that each instrument, with simple and homogeneous substances, must measure one and the same physical property and gives results which are either in actual agreement with, or proportional to, the results obtained by the other forms of test.

In practice, however, the use of relatively pure metals in the unworked or annealed condition is comparatively rare, unless we include in this category wrought iron and mild steel. Carbon steels and special steels consist largely of alloys, the complexity of which is profoundly modified by heat treatment; while copper, zinc, and their alloys are frequently hardened by rolling, drawing, or other mechanical treatment. The very important question therefore arises as to the extent to

TABLE II. PERCENTAGE OF LOSS OF HARDNESS OF HARDENED STEEL WHEN TEMPERED TO VARIOUS TEMPERATURES, AS MEASURED BY DIFFERENT HARDNESS TESTING APPARATUSES

Temperature of Heating, Degrees C	Brinell Method (0.83 per cent Carbon)	Martens Sclerometer (0.95 per cent Carbon)	Jaggar Micro-sclerometer (0.86 per cent Carbon)	Shore's Method (0.83 per cent Carbon)
160	..	2.5	1.8	3.7
200	13	14.0	5.4	2.7
300	38	41.0	9.1	11.1
400	68	70.6	23.6	33.0*
500	94	87.5	64.0	92.5
600	100	95.7	94.5	100

* At 380 degrees C.

which the different methods of testing agree in their values for the hardening and tempering of steel, and for the hardness caused by mechanical treatment. From preliminary observations on the latter point the author is inclined to believe that metal which has been mechanically treated, as with hard-drawn rods or rolled sheets, has its tenacity increased out of proportion to its hardness as measured by a file or cutting tool. The sclerometer shows relatively little difference, for example, between hard-drawn and annealed copper, while the scleroscope shows an exaggerated effect, at all events in some cases. As the Brinell test closely follows the tenacity, it too may be expected to show marked difference between worked and annealed samples. The result in some cases is likely to be a confusion between elasticity or tenacity on the one hand, and true or mineralogical hardness on the other. For example, a piece of hard-rolled copper may give a greater hardness number than one of mild steel. Yet a tool made of mild steel will always cut copper, and no amount of cold-rolling will make copper cut steel. Hence great care is required when hardness values for different materials are compared and further information in this direction is desirable.

Hardness of Steel in Hardened, Tempered or Annealed Condition

The question of agreement in reference to the true hardness of a sample of steel in the normal, hardened, tempered, or annealed condition is perhaps of even greater importance. To illustrate the kind of difficulty which arises, reference may be made to some recently published results by E. Maurer, in which samples of steel with varying content of carbon were heated to ascertained temperatures, quenched, and afterward tempered or annealed at given temperatures. The hardness of the samples was then determined. When the tempering heat was 300 degrees C., the loss of hardness in a sample containing 0.83 per cent of carbon was 11.1 per cent by the Shore method, and 38.0 per cent by the Brinell test. A steel with 0.95 per cent carbon tested in a similar manner by Heyn and Bauer with a Marten's sclerometer gave a loss of hardness of 41.0 per cent; while lastly Boynton, with a Jaggar sclerometer, using a steel with 0.86 per cent carbon, has recorded a loss of hardness on tempering at 300 degrees of only 9.0 per cent. The question may be put in this way: The steel is suited for making wood-working tools, if properly hardened and tempered. Is 300 degrees C. a proper tempering heat? According to the Shore test and the Jaggar test the tool should be hard and cut well; but according to the Brinell test and the Martens sclerometer it has lost nearly half its original hardness, and should rapidly lose its cutting edge. Maurer states that everyday experience shows that with this class of tool steel a tem-

pering heat of 300 degrees renders the metal useless for woodworking.

The results of the four sets of experiments are given in Table II.

The values are graphically represented in the accompanying illustration, from which it will be seen that the greatest difference occurs at about 300 degrees C., the loss of quenching hardness due to tempering being about four times as great when tested by the two first methods as compared with the results obtained when the steel is tested by the two latter methods given in the table.

Further, Martens and Heyn have recently pointed out that in the ball test for hardness the indentations are frequently not circular, and are therefore difficult to measure, and that when testing hard materials the ball itself is appreciably flattened while under load. To diminish these sources of error Martens has introduced a special form of apparatus for measuring the depth of the indentation.

It is evident, therefore, that further research and comparison is required before agreement in principle can be arrived at with hardness tests for hardened, tempered, or mechanically treated metals.

* * *

ALLOY STEELS FOR MOTOR CAR CONSTRUCTION*

The cost of the materials used in automobile construction amounts to about sixty per cent of the total cost of production. In view of this fact, the kind of material best suited for the more vital parts is highly important. In the following the composition and treatmnt of some of the most commonly used alloy steels are reviewed.

TABLE I. NICKEL STEELS

Carbon	Manganese	Nickel	Elastic Limit, tons	Tensile Strength, tons	Elongation in 2 inches, per cent	Reduction in Area, per cent	Treatment
0.21	0.86	3.48	68	112	13.7	45	1550 F. oil 600 F.
0.25	....	3.50	85	109	13.4	..	1550 F. oil 600 F.
0.27	....	3.50	86	110	13.3	51	1550 F. oil 600 F.
0.18-0.28	0.60-0.90	3.5	68	103	12.9	54	1550 F. oil 600 F.
0.18-0.28	0.60-0.90	3.5	84	116	12.4	48	1600 F. brine.
0.25	0.60-0.90	3.5	88	121	12.2	48	1600 F. brine.
0.23	0.61	3.54	103	114	14.0	50.7	1550 F. water 212 F.
0.14	0.63	3.64	78	88	15.0	54.6	1500 F. water 212 F.
0.14	0.63	3.64	30	41	33 5	72.4	1400 F. oil 1200 F.
0.35	0.45	3.39	77	84	15.5	55.5	1500 F. water 900 F.
0.35	0.45	3.39	130	137	10.0	36.3	1500 F. water 430 F.
0.25	0.86	3.45	31	45	31	60	Natural, as rolled.

Nickel Steel

Nickel steel is the most generally used of the alloy steels. The best quality contains 0.20 to 0.25 per cent carbon, 3.50 per cent nickel, 0.60 to 0.90 per cent manganese, and not over 0.04 per cent sulphur and phosphorus. With carbon and nickel as given above, the manganese content ought never to exceed the limits menticned. A slightly lower carbon content is sometimes used for case-hardening purposes, and a higher carbon percentage is much used for crank-shafts. Nickel steel is usually made in the basic open-hearth furnace. It is an excellent steel for case-hardening, and is easier to machine than other alloy steels.

Chrome-Vanadium Steel

The chrome-vanadium alloy steels are preferably made in the crucible or electric furnace, although the open-hearth process is also much used for the purpose. The open-hearth product, however, is somewhat uncertain, and while springs of steel made by this process may be better than those made from ordinary crucible steel, they cannot be compared with springs made of crucible chrome-vanadium steel. For excellent quality the latter product constitutes the highest attainment of the steel makers' art.

Chrome-vanadium steel made with high carbon content is suitable for oil-hardened gears and springs. When made with a low carbon content it is used for case-hardened gears, and, when oil quenched and annealed, for axles, shafts and steering knuckles. When a better material than the best nickel steel is needed, the various kinds of chrome-vanadium steel are to be recommended. They can be easily forged and can be machined more readily than chrome-nickel steels of corresponding carbon percentages.

Chrome-Nickel Steels

Chrome-nickel steels are made either with a high carbon content, and used for oil-hardened gears and springs, or with a low carbon content, in which case the steel is used for axles, shafts, forged parts, and case-hardened gears. The high carbon steel carries about 0.5 per cent of carbon, while the low carbon alloy carries 0.25 per cent. The nickel content is from 2 to 3.5 per cent, while the chromium varies from 1 to 1.5 per cent. A special nickel-chrome-tungsten steel is sometimes used for springs. Nickel-chrome steels possess excellent static qualities, but present difficulties in heat treatment, forging and machining.

Silico-manganese and silico-chrome steels with medium and low carbon contents are used to a considerable extent abroad for springs and gears. Their relatively low cost favors their use, but they do not stand up well when subjected to shocks, and are too sensitive to heat treatment. When handled with great care they give good results where the temperatures for the heat treatment can be accurately gaged. Chrome steels with high carbon content are used to a considerable extent for balls and ball races. Tungsten steels are universally used for making magneto magnets.

TABLE II. NICKEL-VANADIUM STEELS

Carbon	Manganese	Nickel	Vanadium	Elastic Limit, tons	Tensile Strength, tons	Elongation in 2 inches, per cent	Reduction in Area, per cent	Treatment
0.34	0.17	3.88	....	29	43	27.3	54	Natural as rolled.
0.33	0.16	3.72	0.12	41	54	23.8	53	Natural as rolled.
0.33	0.16	3.40	0.24	49	66	17.8	40	Natural as rolled.
0.34	0.17	3.88	....	37	51	16.5	51	1500 F. oil 1150 F.
0.33	0.16	3.72	0.12	51	59	24.0	61	1500 F. oil 1150 F.
0.33	0.16	3.40	0.24	59	62	21.0	61	1500 F. oil 1150 F.
0.34	0.17	3.88	...	59	66	15.5	55	1500 F. oil 600 F.
0.33	0.16	3.72	0.12	70	76	14.5	56	1500 F. oil 600 F.
0.33	0.16	3.40	0.24	82	85	15.0	55	1500 F. oil 600 F.
0.24	0.72	3.33	0.12	38	49	27.0	64	Natural as rolled.
0.24	0.72	3.33	0.12	71	100	11.6	36	1600 F. oil.
0.24	0.72	3.33	0.12	92	117	14.5	52	1600 F. water.
0.24	0.72	3.33	0.12	91	116	15.2	57	1600 F. brine 400 F.

Heat Treatment of Alloy Steels

While the best alloy steels are none too good for most of the parts in automobile construction, their qualities will not become pronounced unless they receive proper heat treatment. It is waste of money to buy good alloy steels without knowing how to properly treat them to bring forth their exceptional qualities. For gaging the heat a pyrometer is necessary, but it is too often supposed to take care of itself. The best pyrometer of the thermo-couple type should be regularly inspected. The protecting tubes should be frequently examined and renewed, and the electrical contacts looked over.

The heat treatment operations depend upon established scientific facts, and a lack of appreciation of this causes many people to buy high-priced alloy steels from which they get no better results than from carbon steel properly handled. As an example of the effect of heat treatment may be mentioned a chrome steel which in its rolled condition had an elastic limit of 158,000 pounds, 5 per cent elongation, and 9.4 per cent reduction in area. The same steel, oil tempered and annealed, had an elastic limit of 153,000 pounds, 14 per cent elongation and 52 per cent reduction in area. In other words, the material was transformed from brittle to tough without appreciably affecting its elastic limit. Nickel steel similarly treated will have the elastic limit raised twenty per cent, with its elongation unchanged and its reduction in area improved.

The accompanying tables show typical analyses, treatment and tensile strength of nickel, nickel-vanadium, chrome-vana-

* Abstract of paper by Mr. John A. Mathews, read before the Franklin Institute, Mining and Metallurgical Section, April 1, 1909.

dium and chrome-nickel steels. Many sources of information have been drawn upon in the compilation of these tables, as, for instance, the data published by the American Vanadium Co., experimental data obtained by tests made by the writer, and the commercial tests made on the steels of many makers. The elastic limit and tensile strength are given in tons per square inch, and the elongations are measured on 2-inch test specimens, ½ inch in diameter. It should be noted that the figures given must be used with some caution. Because a ½-inch test piece, oil tempered and annealed, gives an elastic limit of 75 tons per square inch, it does not follow that a 1½-inch bar similarly treated will have the same elastic limit. The hardening action in quenching does not penetrate very deeply in the large bar, while in a small one it may penetrate to the center.

In the column marked "Treatment" is given the temperature to which the steel is heated before quenching, followed by the liquid in which it is quenched; where a third temperature is given it indicates the temperature to which the steel is reheated to draw the temper or anneal. This will make clear such terms as "1,600° F. oil 600° F."

For springs it seems that no material is better than crucible chrome-vanadium steel. The tempering of this steel is quite simple. The springs made from it should be heated to from 1,675 to 1,700 degrees F. and quenched in oil. The temper is then drawn according to the nature of the spring, and the duty expected. The drawing range is very wide, varying from 600 to about 1,000 degrees F.

Case-hardened versus Oil-hardened Gears

Both case-hardened and oil-hardened gears are largely used in automobile construction. As previously mentioned, the chrome-vanadium, chrome-nickel and silico-manganese alloys are made with both high and low carbon contents. The former

TABLE III. CHROME-VANADIUM STEELS

Carbon	Manganese	Chromium	Vanadium	Elastic Limit, tons	Tensile Strength, tons	Elongation in 2 inches, per cent	Reduction in Area, per cent	Treatment
0.26	0.39	0.78	0.17	44	68	20	64	Natural as rolled.
0.26	0.39	0.78	0.17	103	139	3	8.2	1570 F oil 400 F.
0.27	0.50	1.00	0.17	33	45	28	62	Annealed 1475 F.
0.27	0.50	1.00	0.17	52	63	21	56	Oil tempered and drawn to various degrees.
0.27	0.50	1.00	0.17	62	65	17	62	
0.27	0.50	1.00	0.17	70	74	17	57	
0.27	0.50	1.00	0.17	100	106	12	51	
0.27	0.50	1.00	0.17	112	116	11	39	
0.40	0.77	1.22	0.19	34	50	26	62	Annealed.
0.40	0.77	1.22	0.19	98	104	10	36	1650 F. oil 840 F.
0.30	0.50	1.00	0.16	71	76	16	56	1650 F. oil 1025 F.
0.38	0.73	1.19	0.18	41	65	22	67	Natural as rolled.
0.38	0.73	1.19	0.18	110	144	10.8	47	1660 F. oil 600 F.
0.38	0.73	1.19	0.18	64	113	12.9	53	1660 F. oil 850 F.
0.33	0.54	1.24	0.20	64	71	15.5	56	1500 F. oil 1125 F.
0.33	0.54	1.24	0.20	95	104	11.0	38	1600 F. water 600 F.
0.45	0.58	2.37	0.30	88	94	13.2	46	1600 F. oil 1125 F.
0.45	0.58	2.37	0.30	138	146	6.0	16	1600 F. oil 430 F.
0.36	0.21	2.78	0.24	60	104	4.1	88	Natural as rolled.
0.36	0.21	2.78	0.24	65	72	20	56	1500 F. oil 1150 F.
0.36	0.21	2.78	0.24	98	104	13	45	1500 F. oil 600 F.

contains about 0.45 to 0.60 per cent carbon and enough other hardening elements so that by merely quenching the steel in oil from a bright red heat, surface hardening is produced sufficient for ordinary wearing purposes, while the hardness does not penetrate deeply into the gear, but leaves a tough and strong core. The low carbon alloy steels, with about 0.20 per cent carbon, require to be case-hardened in order to produce sufficiently hard surface for wearing purposes. The writer's observations lead him to prefer the case-hardening gear, the following conclusions being based on the results of direct tests on thousands of gears.

1. The static strength of case-hardened gears is equal to that of oil-hardened gears, assuming that in both cases steel of the same class of appropriate composition has been used, and the respective heat treatments have been equally well and properly conducted.

2. Direct experiments prove that case-hardened gears resist shocks better than oil-hardened.

3. The case-hardened gear resists wear incomparably better, although it is perhaps not as silent in action.

The strong objection to the case-hardening is in nine cases out of ten doubtless due to the fact that the case-hardening operation is not properly understood. The depth of the hard case or covering, the time and temperature required to produce certain results, and the exact control of the conditions, together with an accurate knowledge of the material to be treated, are factors which enter into successful case-hardening.

To obtain the best results in case-hardening ordinary carbon steel, the following rules should be observed. Steel containing

TABLE IV. CHROME-NICKEL STEELS

Carbon	Manganese	Nickel	Chromium	Elastic Limit, tons	Tensile Strength, tons	Elongation in 2 inches, per cent	Reduction in Area, per cent	Treatment
0.37	....	2.9	1.04	60	78	18.5	61	1475 F. oil 1200 F.
0.37	....	2.9	1.04	77	84	16.	56	1500 F. water 1100 F.
0.45	....	2.0	1.0	70	90	8.0	20	Oil-temp. and annld.
0.25	....	2.0	1.0	50	65	12.0	30	Oil-temp. and annld.
0.25	....	3.0	1.5	57	64	15.0	65	Annealed.
0.25	....	3.0	1.5	110	116	6.0	40	Hardened—oil.
0.50	....	2.0	1.0	33	46	27.0	64	Natural as rolled.
0.50	....	2.0	1.0	72	134	6.0	23	Tempered.
0.30	....	2.0	1.0	35	53	18.0	45	Natural as rolled.
0.30	....	2.0	1.0	68	98	9.0	37	Tempered.
0.30	....	2.0	1.0	45	55	25.0	55	Oil-temp. and annld.
0.40	0.18	2.1	0.80	60	76	12.8	37	Natural as rolled.
0.40	0.18	2.1	0.80	58	66	17.5	40	1500 F. oil 1150 F.
0.40	0.18	2.1	0.80	106	118	10.0	34	1500 F. oil 600 F.
0.40	0.18	2.1	0.80	70	79	15.5	48	Annealed 1150 F.

less than 0.12 per cent of carbon, and with a low percentage of manganese (less than 0.30 per cent) should be used; the case-hardening should be accomplished by a chemically definite material, such as a mixture of 60 per cent charcoal and 40 per cent barium carbonate, and at a temperature between 1,560 to 1,920 degrees F. The higher the temperature, the more rapid will be the case-hardening. After the case-hardening operation, allow the steel to cool down to about 1,100 degrees F. Then re-heat the work to be case-hardened, and quench it at 1,650 degrees F. This heating and quenching has the effect of toughening the center, but the outside will be coarse-grained and brittle; therefore heat the material a second time to 1,470 degrees F. to render the outside non-brittle.

This procedure is more elaborate than that most commonly used, where pieces are dumped directly from the case-hardening boxes into water. The process, however, can be somewhat modified if one uses a good grade of nickel steel, low in carbon, and after having case-hardened it at the appropriate temperature, permits the material to cool off in the boxes before re-heating and quenching. In this case, if the material is re-heated but once to 1,470 degrees F. the result will be fully equal to or better than those obtained by the most careful annealing and double quenching of ordinary carbon steels. It is, however, better to give a double quenching, as then extraordinary toughness and wearing qualities are obtained.

An ideal way of making a nickel steel gear consists in first annealing the blank than rough machining it approximately to size, and then re-annealing before taking the last finishing cut. The gears are then packed in a mixture as mentioned, heated to a temperature of about 1,625 to 1,650 degrees F., carbonizing to a depth of about 1/64 to 1/32 inch. The gears are then permitted to cool in the boxes, are heated to 1,500 degrees F., and quenched in a hot brine or calcium-chloride solution, and finally re-heated to 1,375 or 1,400 degrees F. and quenched in oil. The temper need not be drawn.

Another important point is that of drop forging small parts which can also be made from bars in automatic machines. No steel is improved by drop forging, although some steels are less susceptible to injury than others. In drop forging work, in order to give plasticity, the material must be heated very hot. An investigation of drop forging and bar cut gears, the former being the product of one of the foremost drop forging companies, showed that under static test the bar cut gears were fully 25 per cent stronger and their resistance to shock was also greater.

THE COMMERCIAL AIRSHIP

C. A. McCREADY*

Broadly stated, there are two distinct systems followed by inventors in their efforts to produce a vessel that can navigate the air. In the first, the vessel is heavier than air, with wings or supporting planes, and equipped with machinery light enough and powerful enough to force it upward and keep it in motion in the air; in the second, it is lighter than air, so that it can of itself rise and carry a definite load. The problem is purely a commercial one, as in transportation on the land and on the sea, and the proper gage of the success of any aerial vessel is its availability for commercial purposes. With commercial success achieved, all other needful purposes can readily be met. As yet we are in the experimental stage, the best results by either system falling far short of commercial requirements. It is well, therefore, to analyze the underlying principles with a view to determining which system offers the best assurance of final success.

The heavier-than-air machines, popularly known as flying-machines, have the advantage of cheaper cost of construction and operation. On the other hand, the construction of such machines is necessarily frail, the risk of being overturned by a sudden change of wind is ever present, they can only rise under favorable conditions, and even under favorable conditions can only remain a limited time in the air. Many improvements can, and doubtless will, be made that will reduce the force of these objections; but even if entirely removed, the further objection still holds that such vessels cannot remain at rest in the air even for a moment, so should any accident befall the propelling machinery, the vessel must descend, whether under control or not, and whether or not there is available a suitable place for landing. The carrying capacity is also limited, and any increase to commercial proportions seems doubtful, since the weight increases as the cube of the dimensions while the carrying capacity increases only as the square.

Of lighter-than-air machines the general public is as yet only familiar with those based on the balloon principle; which means that the air contained in the envelope is forced out and a lighter gas substituted, the difference between the weight of the air and the weight of the gas furnishing the ascensional force, after deducting the weight of the envelope and appurtenances. The advantages of the balloon over the flying-machine are important: it can remain longer in the air, it can ascend higher, and it can carry a greater load. However, the disadvantages are serious, although recent developments have tended to modify some of them. First, the gas—whatever gas is used—is an element of danger. It is also expensive, inasmuch as it must be renewed with each ascension. The process of inflation is likewise bothersome. In a limited sense, the balloon can rise to such altitude as may be desired, yet it can only do this by discarding the ballast it has taken along. It can also descend at will, yet to do so part of the gas which caused it to rise must be released. Neither the ballast nor the gas, once released, can be restored without coming to earth; so the possibilities of the balloon while in the air are limited, and its return to the air is made possible only after delay, inconvenience and extra cost.

The rigid construction of recent German balloons has removed some of the previous disadvantages of this system, and also has permitted making the balloon dirigible, in a modest way, even while carrying a load such as the flying machine could not support; yet little of practical value has so far resulted from the enormous sums spent in experiments. Still enough has been learned to make it clear that it is through the lighter-than-air principle alone that aerial transportation must come, even though balloons themselves, however modified in form, may be incapable of solving the problem.

As already stated, aerial transportation is a purely commercial problem, and to be a success the airship must be capable of meeting the every-day requirements of commercial transportation. It must be able to support and carry a substantial load for an indefinite time without coming to earth. It must be able of itself to rise to such altitude as may be desired, whether it be a few feet above the earth or ten thousand feet or more, and to remain at the chosen level, either at rest or in motion, indefinitely. It must be equally able to descend at will, always under the absolute control of the pilot.

All this is possible only on the lighter-than-air principle; yet abundant experience has shown that it is hopeless to expect so much from any vessel which gets its ascensional force from inflation, as with the balloon. There only remains the principle of deflation,—that is, exhausting the air and leaving a vacuum,—and by the proper application of this principle it will be found that all of the above requirements of the commercial airship can be met.

Let us assume a thin steel cylinder of high tensile strength, say 26 B. W. G.,* (0.018 inch) so as to permit of the lightest construction consistent with safety; the diameter to be about 150 feet, and (including cones at either end to facilitate passage through the air) of an extreme length of say 750 feet from apex to apex of the cones; the cylinder and cones to be supported internally by a system of bracing, light in weight but so constructed as to prevent collapse or buckling when the air is exhausted. The natural objection that such construction is impracticable must, for obvious reasons, be passed over for the present without further explanation than that the entire system has been worked out to the final detail, and attested by engineers of national reputation. Such an envelope would contain over 420 net tons weight of air. The weight of the steel cylinder with its internal bracing, including the weight of the attached car, with furnishings and all necessary machinery, would be, roughly, 270 net tons, leaving an extreme lifting force of about 150 net tons with the air entirely exhausted from the cylinder. Leaving say 50 tons of air in the cylinder as a reserve, there would still remain a lifting force of 100 net tons, or 200,000 pounds, the equivalent in weight of at least 1,000 men. If so much lifting force were not required, the surplus would remain as an extra reserve force of air in the cylinder. It is, of course, understood that where no strain appears, the lightest material available, as aluminum, would be used, particularly in the furnishings.

On a small scale the vacuum system is not now practicable; but it becomes proportionately more efficient as the size is increased, which is very important from the commercial point of view. It may be well to note how the vacuum principle as applied to airships will work out in practice. The lifting force itself is the weight of the air withdrawn from the cylinder, after deducting the weight of the cylinder, car and equipment. When the car is loaded ready to be transported, pumps are set to work to exhaust the air from the cylinder, and when the weight of the air exhausted overbalances the weight of the airship and its load, it will rise; and as more air is exhausted, the airship will rise higher until the desired height is reached, whether it be a few feet above the ground or high above the clouds. To descend, it is only necessary to open valves and allow air to enter until the added weight causes the airship to descend. This rising and descending can be adjusted at the will of the pilot, so as to take advantage of whatever atmospheric level is most favorable for navigation; and it is accomplished without difficulty and without cost, by using the very medium in which it floats to increase or decrease the weight of the airship.

The first requirement in aerial transportation, as elsewhere, is safety, and in all calculations concerning the vacuum airship this has first of all been provided for. It must, however, be remembered that while vessels on the sea must at times combat the combined fury of wind and waves, there is one less element of danger in the air; and this danger is minimized in the vacuum airship through its ability to change its specific gravity at will. If storms are raging near the earth, it can rise above them; if the upper air is violently disturbed, it can descend to the quieter level near the earth.

The speed at which this airship can travel must partly depend on the varying conditions met, but a minimum of 100 miles per hour is provided for. Bearing in mind the speed actually attained by the crude devices now on exhibition here and abroad, this estimate for a scientifically constructed air-

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* The dimension of ¼ inch, given in the note "Zeppelin's Last Record—The De Bausset Vacuum Airship," July, 1909 issue of MACHINERY, was erroneous.

ship capable of carrying the necessary machinery does not seem extreme. This would permit of a passage across the Atlantic within one and one-half days, or one-third of the time required for the fastest ocean passage yet made. The same rate of speed in a continued trip—which is well within the limits of possibility—would permit of circumnavigating the earth in ten days.

In various other ways the vacuum airship may exert an influence almost incalculable on human affairs. What better health resort can be imagined than the upper air for victims of tuberculosis and kindred ailments? What better method of exploring distant regions, now almost inaccessible, and searching out their hidden treasures? How better could relief be carried to famine-stricken districts, when each day's delay means the sacrifice of many lives?

Unlike the balloons and flying machines of the present, this airship was not designed for war purposes. That it would be useful in time of war is self-evident. But it is hoped that it may be more useful to the world by showing the futility of building and supporting warships and fortifications that could be so easily destroyed, and of maintaining large standing armies that could readily be put out of action by it, and thus relieve the nations of the world of the tremendous burdens they are now compelled to support in time of peace, and perhaps hasten the time when war shall be no more.

In conclusion, it is only proper to state that the vacuum principle as applied to airships is based on the researches and experiments of the late Dr. Arthur de Bausset, a physician by profession, and a scientist of very high attainments; and it is the earnest belief of those most familiar with his work, that when the history of aeronautics is finally written in the light of facts now known only to a few, to him will be given the credit for having made possible the commercial conquest of the air.

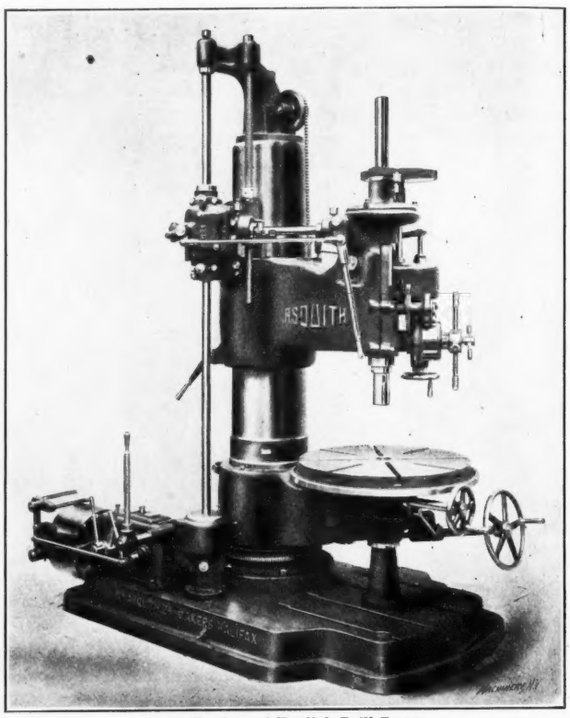
* * *

NEW ENGLISH UPRIGHT DRILL PRESS

JAMES VOSE*

The firm of Wm. Asquith, Ltd., Halifax; formerly built a wide range of machine tools in conformity with the then common English practice. During the last few years, however, they have specialized in the manufacture of medium and heavy drilling and boring machines, including the radial, upright and horizontal types, and have met with considerable success. We herewith illustrate their most recent design of vertical drill press.

The principal advantages claimed for these machines are an unusual degree of handiness of adjustment, coupled with extreme rigidity and freedom from deflection in the frame or table. They are built in three sizes to admit work up to 36, 48, and 60 inches diameter. The diameters of the driving parts of the spindles are 2¼, 3, and 3½ inches respectively, and the vertical feeds for the three sizes are 11, 15, and 18 inches. The 36-inch machine has 8 speeds and 4 feeds, and the 48- and 60-inch sizes have 12 speeds with 4 and 6 feeds respectively. The coarsest feed provided is 1/32 inch and the finest 1/150 inch per revolution of spindle. The maximum distance from spindle nose to the table varies from 28½ to 30 inches in the different sizes, and from spindle nose to the base-plate, from 53 to 57 inches. The heads may be raised or lowered by power within a range of 32 inches in the case of the 36-inch press, 34 inches on the middle size, and 36 inches on the 60-inch machine. As will be noticed, the main drive from the line shaft is through a gear box mounted on the base at the rear of the column. The constant-speed belt, which is 4 or 5 inches wide, runs at from 1,500 to 1,800 feet per minute. The work tables are surrounded by a trough which catches the surplus lubricant, and their working diameters are 30, 42, and 48 inches, respectively, for the different machines. The weights of the machines—which may, of course, be electrically driven if desired—range between 5,500 and 9,500 pounds. Some of the constructional features which may be mentioned are as follows: The high-carbon steel spindles are made larger in diameter where they bear in the sleeves than at the driving parts, and they are rigidly supported by the sleeves even when out at the full length of the traverse. Ball thrust bearings are used, and the spindles have quick up-and-down adjustment with fine hand- and power-feed motions and an automatic trip motion with index dial and safety stops for the prevention of over traverse. The powerful friction feed is also capable of being instantly stopped or applied. For tapping and stud fixing, the reversing motion is worked by the same lever which stops or starts the spindles and controls the vertical motion of the heads, the lever being brought to the front of the head, on which it is carried, for easy access from the operator's working position. The head has no radial adjustment, the present construction being considered more rigid. The standard carrying the head and table is in one piece down to the foundation plate, to which its unusually large base is



Rigid Design of English Drill Press

bolted. Special stress is laid on the assurance thus obtained of practical absence of deflection. The arm carrying the table is very strong and it has a bearing of large diameter and considerable length on the lower portion of the standard. The table can be very easily and quickly adjusted radially by a large hand-wheel (seen in the illustration attached to an inclined shaft), worm and wheel. A fine, accurate and quick adjustment is thus available. The tables also have a rotary motion in the arm bearing through a hand-wheel, worm and wheel, and by this combination of motions any portion of the table can be rapidly brought under the drill spindle. The table, which can be swung entirely clear of the base when desired, is fitted with a foot, as shown, which prevents deflection under any cut which can be imposed. All the driving gears are of steel, and all bearings bushed with gun metal. Particular attention has been paid to the handy locating of locking and manipulating levers and also to lubrication. By way of taking advantage of the satisfactory support afforded the spindle, a very handy attachment is supplied for milling keyways in spindles or shafts. This takes the form of a fixture which is self-setting on the table. The top portion of the fixture can be screw-traversed by hand and it is arranged as a V-block with T-slots on each side for bolting down the work. Generally, the machines are considered by the builders to combine—within their range—the handiness of the best standard radial machines with the rigidity of the best type of vertical drill press. The engraving shows the 36-inch machine.

* * *

It is stated in the *Cement Age* that the Pullman Company has completed an all-steel sleeping car with concrete floor laid on steel girders. The new car consists entirely of steel and concrete, with the exception of the upholstery, making it as nearly wreck- and fire-proof as possible.

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MACHINE SHOP PRACTICE*

LAYING OUT WORK—1

It is necessary prior to many machining operations to first lay out lines indicating just where the finished surfaces should be, so that when the work is completed all machined surfaces will be in proper relation to one another. Another purpose of such lines, providing they are properly located, is to enable the machinist to remove an average amount of metal from the various surfaces; this is important, for, by way of illustration, if too much metal were removed in facing a boss, it might not be possible to finish another surface to a certain required dimension from the first. In addition, the

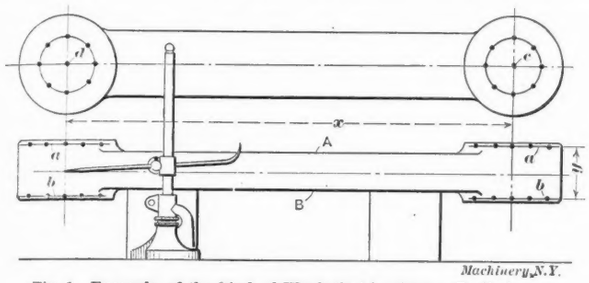


Fig. 1. Example of the kind of Work that is given a Preliminary and a Final Layout

finished faces are in a more orderly relation with those parts which are left rough, and therefore the work presents a more pleasing appearance. At the present time there is less of this class of work done than formerly, as the numerous jigs and fixtures now used, so locate the work and guide the cutting tools that lines indicating finished surfaces are unnecessary. When the parts are not manufactured in quantity, however, and in small shops where there are few jigs, it is frequently necessary to lay out work.

With the exception of certain small parts, a surface plate or other flat surface, such as a planer platen, is almost indispensable for this operation. There are various styles and sizes of laying-out plates, the type depending largely upon the class of work for which it is intended. A table with a circular top which revolves on its base, is very convenient for general work of a light character, and by reason of the movement possible, all sides of the work being laid out may be easily turned toward the workman and also into the best position for light. Large rectangular plates are used in some shops for heavy work, which are sometimes bedded into a firm concrete foundation in order that the weight of the part being operated upon will not spring the surface of the plate. The advantage of placing work on a flat surface is that vertical dimensions, even when they are between points not in

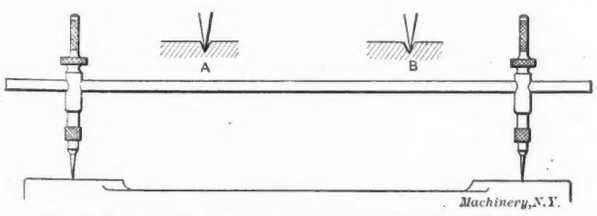


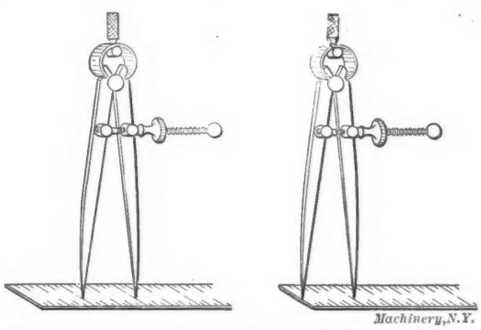
Fig. 2. Testing the Accuracy of the Distance between Centers with the Trammels

the same plane, may be easily laid off, and, in addition, both vertical and parallel lines may be drawn on any part of the work by the use of a square and surface gage. Among the more important tools for this class of work may be mentioned V-blocks, parallel pieces and height blocks of various sizes, surface gage, square, dividers, trammels, scriber, prick-punch and the hammer. As these tools are in common use in every shop, a description of them will not be given.

Some parts are laid out prior to any machining, but it is often advantageous to first finish some surface, so that lines may be accurately located in correct relation to one another, from this finished part. Upon some work it is not practicable to plane a surface without first laying out the work in a rough way, as it is necessary to secure average allowances in order that other surfaces may be properly trued. A finished surface facilitates lining out to such an extent, however, that this first or tentative lining is often advisable, so that some broad surface, as for example the base of a frame or bed, may first be planed. Furthermore, it is not practicable to lay out most work in one operation, as some of the lines can often be more conveniently and accurately located on previously finished surfaces, and, besides, if every line finally required were laid out in the beginning, some of these would be removed by the turning or planing tools. Therefore, the laying out of parts is often divided into a preliminary and a final operation.

A simple example of a preliminary and final layout, is shown in Fig. 1. First a center line is drawn central with the sides *A* and *B* and extended to the ends with the surface gage, as illustrated. The lines *a* and *b* are then drawn parallel to and central with this center line and a distance *y* apart equal to the dimension given on the drawing. The faces *a* and *b* are then ready to be machined, and after this operation the lines for the hole in each end of the link are laid out on the finished surface as shown in the plan view.

In order that the lines drawn upon metal surfaces may be plainly visible, some suitable preparation is applied to those surfaces upon which lines are to be drawn. Common chalk or a mixture of whiting and alcohol and water is often used on rough castings, while a solution of sulphate of copper ("blue stone") gives excellent results on finished surfaces. The thin film of copper which is deposited makes it possible to easily see fine lines, because of the difference of color between the copper and the metal beneath. When the latter method is employed it is essential that the surfaces be free from oil or grease. As the lines which are drawn are quite



Figs. 3 and 4. Correct and Incorrect Methods of Setting Dividers by a Scale

easily obliterated, especially when they are on a chalked surface, permanence is given them by marking their location with small punch marks, as shown in Fig. 1.

When locating the centers of two circles a certain distance apart it is not advisable to lay off this distance from the edge of a scale, as this can be more easily and accurately done by the use of dividers or trammels. For instance, if the two centers *c* and *d* were to be located, one of them, say *c*, should first be marked lightly with a small center punch. The trammels should then be set to a distance *x* by placing their points directly against the divisions on a scale. Then with one trammel point in the center *c*, an arc could be scribed by the other point upon which center *d* would be located. The accuracy of the distance between two punch marks can be tested by placing the trammel points in them as shown in Fig. 2. If the bottom of each center coincides with each trammel point as shown enlarged at *A*, this will be evident by the "feel" of the trammel and also by the sound emitted as the point is made to strike the bottom. On the other hand, if the centers are, say, too close, one point will bear on the side as indicated at *B*, and the spring necessary to force it to the bottom can easily be felt.

When setting trammels or dividers, the end of the scale should not be used to set one of the points; that is, if a pair of dividers were to be set to say 1 inch, a more accurate setting would be obtained by placing one point in the 1-inch division and the other in the 2-inch division, as illustrated in Fig. 3, than by attempting to use the end of the scale, as shown in Fig. 4.

All parts to be laid out should first be inspected for blow holes or other defects that would render them useless, and

* With Shop Operation Sheet Supplement.

when a casting is the first made from a new pattern, a rough measurement of some of the more important dimensions is advisable. Then in case a core has shifted or insufficient metal is left at some important point, the casting may be discarded before much time has been expended upon it.

Of course, it is impossible to lay down any fixed rule or give any exact method of procedure for laying out machine parts. We shall, however, in a continuation of this article, endeavor as far as possible in the limited space, to teach some of the underlying principles governing this work by giving a detailed description of the way in which one or two typical parts are laid out.

* * *

MINIMIZING THE TIME OF DRILLING OPERATIONS—2

ALFRED SPANGENBERG*

In the previous installment the general requirements of drilling machines and the effect of high speed drills on reducing drilling cost are set forth. In the following the causes of lost time, the requirements of an efficient drilling department, the human element and the wage systems are treated, following which is a summary of the elements which enter into rapid drilling.

Causes of Lost Time

The causes of lost time in a drilling department are located so far back toward the fundamentals of production, and the individual units affording the causes are so seemingly unimportant, and such is the difficulty of recognizing these losses, buried as they are in a busy shop, that they are often overlooked or ignored. This is particularly the case in many large shops where the drilling is done in the various assembling departments. It is interesting to note that where this plan is followed, the drills in one department will be operating at such speeds and feeds as to show a loss of 25 per cent when compared with another department directly beside it but under another foreman; and, at that, both departments will be far below the standard of efficiency they should attain. This condition is due, of course, to the relative efficiency or inefficiency of the foremen. The foremen are not all to blame, however, as they seldom have the time to supervise this work and attend to the other important duties that usually require their attention. When the assembling department is sufficiently large to warrant it, the usual method is to appoint a drill boss who was formerly one of the drill hands, and his experience is limited to the routine practice of

Piece No.	Jig No.
Space No.	No. of Loose Pieces
Machine	
Used for	
Drawing No.	
Used on	
Tools used	

Fig. 2. Form of Jig Index Card

the shop. Another nullifying condition is that when the drilling machines are scattered, they cannot always be used to advantage. As an instance of this I recently noticed in one shop a large multiple-spindle drill that was standing idle because there was no work in the department where the machine was installed that could be handled to advantage on it. In the next department work was being drilled on a radial drill that could be handled 400 per cent faster on the multiple drill.

It may be objected that some of the holes in various machine elements cannot be drilled until part of the assembling operations are completed, and for this reason it is an advantage to have the drills in the assembling department. I contend, however, that with a proper system of laying out the work, or by the use of drill jigs, all holes that are drilled by a stationary machine can be drilled before any assembling operations are started. All other drilling will permit of being handled more economically by portable air or electric drills. This laying out never should be performed by the assemblers or the drill hands. The economy of having this work done by men set apart for that purpose is due to several reasons. Men become expert and quick at this kind of work; the drills are not idle while the drill hands stop the machine to do the laying out; besides, it can be done on a convenient plate with proper tools, to better advantage than otherwise. These men can also act as inspectors.

In brief, the worst "time wasters" may be classified as follows:

1. Waiting for a new job or because of lack of proper handling facilities. Result, the machine is idle.
2. Measuring up jig bushings to find out what tools are needed. Result, the machine is idle.
3. Getting tools, clamps, jigs, etc., from the tool supply room for a new job. Result, the machine is idle.
4. Excessive time in "setting up" a job, due to lack of suitable fixtures for holding the work, or lack of proper instructions as to the best method. Result, the machine is idle.

Add to these the tremendous loss through failure to use the very best speed and feed for the drills and the result is an output far below maximum efficiency. The important consideration is *time*. Time of the workmen running the drills continuously and efficiently—that is the vital point.

Having these usual defects in system and processes clearly in mind and logically grouped for study, we can easily see the advantages to be gained by having a separate department for the drilling, rigidly supervised by a competent foreman and assistants.

Requirements of an Efficient Drilling Department

The drilling department preferably should be located between the machine and the assembling departments for convenience in routing the work. A proper arrangement of the drilling machines will depend on the character of the work, type of drive, etc., so that no definite plan can be stated which would be generally applicable. It is the general practice to group the machines according to their size and type.

No mention has been made of boring machines for the reason that a proper discussion of them is not within the scope of this article. Before passing, however, it is well to state here that boring operations are so closely associated with those of drilling, that the boring machines are frequently placed in the drilling department. In fact, in many instances boring can profitably be performed on the less expensive drilling machines, especially when boring jigs are used.

The problem of running the drills at the proper speed and feed will be greatly simplified by providing each machine with brass speed and feed index plates. These furnish the drill hands with a standard guide and eliminate all guesswork. A judicious use of the data presented in Table II (July issue) will show surprising results.

The equipment for each drilling machine should consist of an abundance of bolts, straps, adjustable blocking, and other necessary fixtures for quickly "setting up" a job. Work chucks will enable the small work to be clamped very quickly. While this factor of "setting up" is far removed from the single problem of drilling, still, it requires a most vital part of the time required to complete a job. The individual equipment should consist of the necessary sockets, bushings, tapping fixtures, wrenches and drifts. The machine number should be stamped on its equipment and a suitable cupboard provided in which to keep the outfit. Suitable work stands are needed for the smaller machines and these should be placed within easy reach of the workmen. For cleaning the chips out of deep holes, a small brass tube fitted with a valve and a dust shield and connected to the air line by a hose, is very useful to have by each machine.

The question of handling heavy work under a drilling machine often becomes quite a problem. For this class of work it will always pay to have good hoisting and handling facilities over each machine. These may take the form of compressed air hoists or an overhead single track carrying an electric hoist serving a number of machines—a very economical arrangement. Of course, where the size of work will war-

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rant it, an overhead electric traveling crane of the bridge type is to be preferred. For handling heavy work under a multiple spindle drill not provided with a work table on wheels, a specially designed jib crane is needed on account of not being able to reach the center of the table with an overhead crane. This arrangement will permit of handling a number of pieces by the jib crane after the work has been placed within its radius.

Drill and boring jigs will, of course, save the expense of having to lay out the work, but where these are not used it is necessary to provide suitable surface plates. Naturally, these will be located near the receiving point for the work so that the work will be laid out before it is sent to the drills. A surface plate with two surfaces, one at right angles to the other, is very convenient, and will enable center lines to be drawn from surfaces at right angles without having to move the work. It may be advantageous to have a style of plate that is not a permanent fixture in any one place, and hence can easily be moved from one part of the shop to another. Ample provision is needed for handling heavy work on these plates.

If the main tool supply room is not convenient to the drilling department, it will pay to institute a separate tool supply room in this department for the purpose of keeping all the tools, jigs, etc., used by the drill hands. A system should be established for taking care of the tools and jigs, keeping them in good condition, and checking up the workmen in regard to those tools in their possession. Some simple system of checking up the men when returning old or broken tools should be kept. This will enable the foreman to locate his careless workmen. The item of broken tools can become a very large one if the workmen find that little attention is paid to this matter.

It is the practice in some shops to supply and keep with each jig a separate outfit of tools. This is an excellent plan but one that cannot always be considered on account of the great expense involved. However, when the tools are in any sense special, such as boring-bars, cutters, special reamers or taps, they always should be kept with the jig to which they belong. A card index of the jigs will be found very convenient. The specimen card shown in Fig. 2 gives an idea of the data required. The cards are indexed according to the forging and pattern numbers. Jig numbers should appear on all detail drawings. The need for an automatic drill grinder already has been pointed out.

Finally, let me urge the necessity of bringing to each drill hand the work and tools for his next job, *before he is ready for it*, and this presupposes a method of removing the work and the tools when the job is completed. Thus will the workman's every duty be eliminated but that of running the drills continuously and efficiently.

The Human Element and Wage Systems

An article on the subject of "Minimizing the Cost of Drilling Operations" would not be complete unless mention were made of the human element and the effect of wage systems on the cost of production. Owing to the simple character of drilling operations and especially when drill jigs are used, it is the custom to have apprentice boys run the smaller machines and to employ drill hands who are handy men, to run the heavier machines. Any foreman who has "been through the mill" will at once recognize the difficulty of securing proper results from these "drill hands" who have been used to the gait of the average shop, especially if they have been accustomed to using the old carbon drills. I have found that the best results are obtained by securing "green men," who are intelligent and active, and train them properly for the work. In this connection the drilling tables and speed and feed index plates mentioned previously will be especially valuable.

The system of pay and character of the reward will depend upon the nature of the work and the method of pay already in use. The principle of extra bonus or the attainment of standard time can easily be applied to almost any system of pay. The determination of standard time should be made carefully, however. If the rates have to allow for the nullifying influences detailed under the subject of "Causes of Lost Time," the firm will be grossly deceived as to the proper output. A proper discussion of wage systems is too broad a subject to be fully outlined here; in fact, that has already been done by a number of able writers. Suffice it to say, however, that the workmen and the foremen should receive a very substantial increase in pay for accomplishing the very desirable results which can be secured.

Summary

Summarizing the elements that enter into the problem of rapid drilling we have:

1. The machine tools.

These must be of a type suitable for the work and must have ample driving power and possess sufficient rigidity; the best type of drive is with a direct-connected variable-speed motor located near the base; the bearings should be self-oiling, and ball thrust bearings should be provided for the spindle; provision should be made for using an abundant supply of lubricant on the drill when drilling steel; there should be a friction drive for rapid power traverse of head on multiple spindle machines and T-slots in the table of multiple spindle machines so as to permit clamping the work.

2. The cutting tools.

High-speed steel drills and cutters are necessary; these must be run so as to secure a maximum output with a minimum expense for grinding; cooling agents are necessary for steel; sockets for driving tools with broken or twisted tangs are valuable; safety tapping devices are needed; improvement in rose reamers to prolong life of reamer is desirable; drill jigs are an important factor in reducing drilling costs; the use of drill tables is recommended.

3. The drilling department.

There is an advantage in having a separate department; machines should be equipped with speed and feed plates; each machine should have its own equipment of fixtures; ample handling facilities are needed; suitable surface plates and men to lay out the work are necessary; it is essential to have a tool supply room in the drilling department and a system for keeping the tools and jigs and giving out the work is needed; the machines should be kept running continuously and efficiently.

4. The human element and the wage system.

The men properly trained are the most efficient; a system of pay is necessary that will reward the extra efforts of the workmen and the foremen.

* * *

A formula for welding cast iron, developed by Messrs. A. Beltzer and C. Delcampe and published in the *Iron and Coal Trade Review*, calls for a flux consisting of 15 per cent lithium chloride, 20 per cent potassium fluoride and 60 per cent potassium chloride. The cast iron surfaces to be welded are preheated, and then covered with the flux powder and heated to the melting point. Additional material is supplied from a rod of cast iron which is also dipped in the flux and presented to the joint where it melts and flows in, filling up the space and making a sound weld. It is claimed that blow-holes in castings may be filled by the addition of cast iron in the above manner and that metal may be added to defective castings to build them up where defective. In short, this can be made a "putting on" process where required. The means for heating are not given, but probably any non-oxidizing flame capable of raising the temperature to the melting point of cast iron, *i. e.*, 2,200 degrees F., can be employed.

* * *

It is expected that the Manhattan bridge over the East River connecting New York and Brooklyn will be ready for traffic about January 1, 1910. This bridge when completed will make the fourth great bridge spanning the East River and the third largest suspension bridge in the world. The contract for the tower on the Brooklyn side was made May, 1901, and the first caisson was put in place February 1, 1903. The first caisson for the New York tower was installed July, 1903, and the foundation was completed in March, 1904, following which the steel towers were soon erected. For further details, see the article on spinning the cables in the October, 1908, number of MACHINERY.

A TWENTY-FIVE DOLLAR TOOL-MAKING JOB

H. J. BACHMANN*

In order to convey somewhat of an accurate idea of the cost of toolmaking, I have here set down in detail the actual amount of money expended on an extension spindle for a drill press, and also the benefits derived from its use.

Having had an excellent demand for our exhaust fans in the smaller sizes ranging from 18 to 48 inches, we found it advisable to facilitate the manufacture of them as much as possible. After a suggested improvement was decided upon,

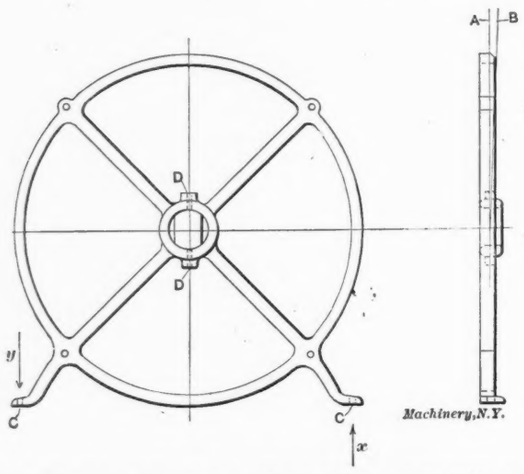


Fig. 1. The Exhaust Fan Frame, which is drilled as indicated by the Arrow y by the use of the Attachment shown in Figs 2 and 3

the manager very thoroughly impressed upon the factory the fact that it was a bad time to spend much money, and that whatever was made must be very simple, etc., and the cost must be kept down to about 25 dollars. With this handicap, the fixture was designed with three objects in view, any

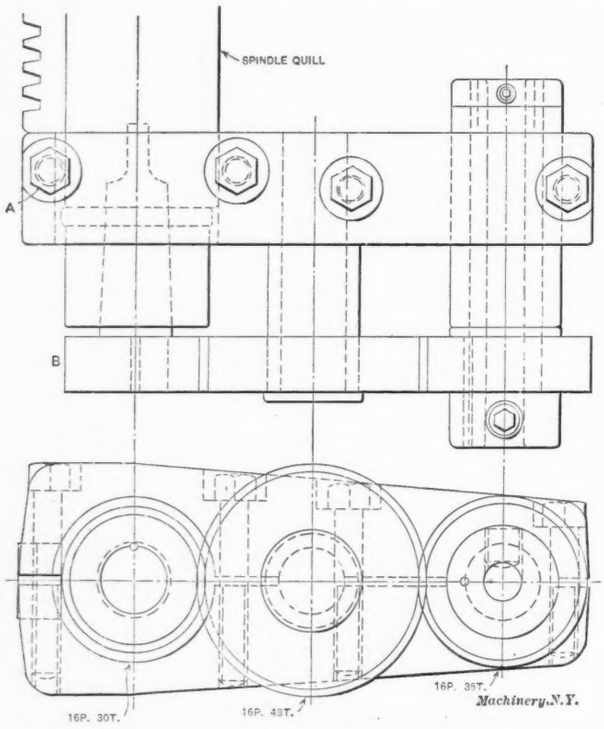


Fig. 2. Extension Spindle and Method of attaching it to the Drill Press

one of which might ordinarily be considered of sufficient importance to justify the expense of construction. In the first place, it was desired to drill the set-screw holes in the hubs of large pulleys used on the fans, without drilling through the rim. We have a number of these pulleys on fans running at high speeds, in places where the belt must run noiselessly—something it will not do if there is a hole in the rim. Second, it was necessary to drill the holes *D*, Fig. 1, for the bearing adjusting screws in both the cast iron side frames. There are four of these screws on each fan, and, inasmuch as the screws, when adjusted, are held in position by lock-nuts, the former must be square to allow the nuts to set down flat. These holes had previously been drilled in the ordinary way with a long drill put through at a slight angle so that the shank of the drill would clear the edge of the frame as shown at *B*. While it is true that the inclination of the hole from the perpendicular position is very slight, it was found that the high speed of the fan and the consequent vibration would in a short time loosen the lock-nut unless it was properly seated. There was one other operation on these frames which gave us quite some trouble and that was the drilling of the holes *C* in the feet. On all sizes up to 3 feet, the drill press was large enough to allow the holes to be drilled in the direction *x*, but on the larger sizes we had to resort to the same makeshift of tilting the frame and using a long shank drill. With our extension spindle, however, we are now able to drill the foot holes, as shown by the arrow *y*, on all sizes of frames. Drilling in this direction also gives the additional advantage of being able to use a standard counterbore if the hole comes so close to the side of the frame that it is difficult to set down the fastening bolt.

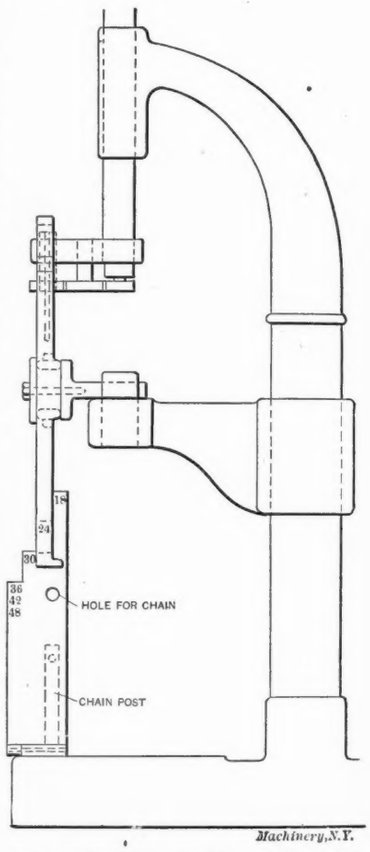


Fig. 3. Drill Press equipped with Extension Spindle and other Auxiliary Attachments

The illustration of the fixture, Fig. 2, will show how well we succeeded in "keeping down the cost." The extension arm was made of two pieces of 1½-inch square, cold-rolled steel clamped together with ⅜-inch cap-screws. A piece of ⅛ x 1½-inch cold-rolled steel held between the two larger blocks made it a simple matter to lay out, indicate, bore and ream the three main holes in the arm. This method of making the arm was adopted in preference to using one piece of 1½ x 3-inch stock and splitting with a ⅛-inch saw after boring. By using 16-pitch gears, the center distances, being in sixteenths of an inch, were easily laid out with an ordinary rule and dividers. Finishing the two end holes first, facilitated clamping the work on the face-plate for boring the center hole because the bolts can be put right through the face-plate and the two end holes. The holes for the ⅜-inch cap-screws were counterbored with a ⅞-inch counterbore so as to make the heads come flush with the outside, thereby giving the fixture a very neat and tidy appearance. The heads of these screws fit a standard Williams drop-forged socket wrench, a much better arrangement, taken altogether, than fillister head screws and a screw driver. The outside of the two sections of the steel arm was finished off to the required shape as shown, not by planing or milling, but by standing it upright in the hack-saw vise and sawing a wedge-shaped piece from each side and grinding off the remaining metal on a disk grinder. The time for cutting off 5 inches of 1½-inch steel with the hack-saw running at 110 strokes per minute was

* Address: 392 E. 169th St., New York.

25 minutes, or the total time for finishing the outside to size was 1 hour 10 minutes. When all work on the arm was completed the clamping cap-screws were taken out and the pieces of ⅛-inch packing strip removed. Three of these clamping screws project into the bored holes of the arm, and are used not only to clamp the entire apparatus together, but two of them also act as pins to hold the intermediate gear shaft and the bearing for the outer spindle in position. The other cap-screw behind the quill of the drill press spindle, bears against a flat on the quill, thus holding the extension spindle rigidly in its proper position directly in front of the main spindle. This flat was made on the quill by cutting 1 inch off the blank end of the feed-rack to accommodate the extension.

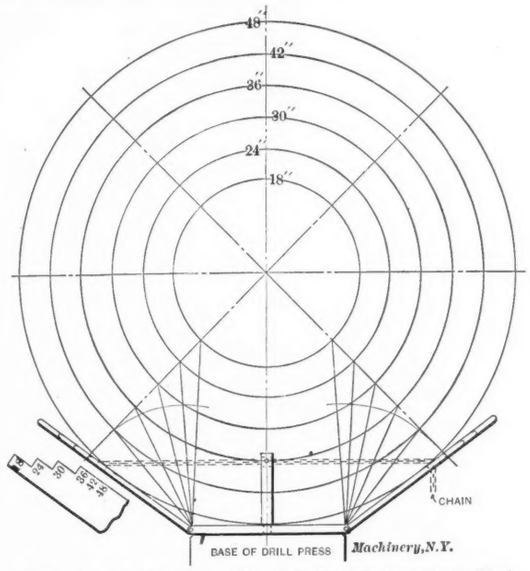


Fig. 4. Layout of a Large Adjustable V-block for Special Work

Not having any facilities for gear cutting it was necessary to buy stock gears. They were fastened to their respective shafts by means of ⅛-inch round pins driven in the ends. The driving gear is fitted to the live spindle with a taper plug in the usual way. The intermediate gear is bronze lined and runs on a shaft having a plain head for an end bearing. The extension spindle has its gear driven against a shoulder, and it runs in a bronze bearing clamped and held in place by the end cap-screw. It is fitted with a fiber washer to take the thrust and a threaded steel collar to take up the end play. A ½-inch reamed hole into which a ½-inch headless set-screw is tapped, serves to hold the drills, the small hexagon wrench furnished with these screws being just the proper thing to use as a key. The drills are the regular twist drills with ½-inch flatted shank, used extensively on blacksmiths' drill presses.

To use the fixture, the end cap-screw *A* is loosened, and the clamping arm is slipped over the driving gear *B* onto the quill, and is drawn into place by tightening the screw *A*. Fig. 3 shows the extension attached to a 20-inch Barnes drill, and also what might be called a few accessories. The fixture did its work so well, ordinarily, that we thought it would pay us to make a complete job of it by adding the two holding devices shown. It is hardly necessary to go into a detailed description of each of these devices, the lower one being simply a sort of a large adjustable V-block (the layout of which is shown in Fig. 4), while that part which is fitted to the table arm is an arrangement made of round cold rolled shafting and used to clamp the frame in an upright position while being drilled. The cost of these was not included with that of the extension spindle, of course.

The following table of the actual cost of the extension spindle alone is figured on the basis of adding 10 per cent of the entire cost to cover the fixed charges, and also on the assumption that none of the material used is kept in stock but must all be bought at retail.

COST OF EXTENSION SPINDLE

1 16-P., 30-T. cast iron gear	$ 0.85
1 16-P., 36-T. cast iron gear	0.90
1 16-P., 48-T. cast iron gear	0.95
11 pounds of square cold rolled steel	0.44
4 ⅜-inch cap screws	0.08
2¾ pounds of Tobin bronze	0.75
5½ pounds of round cold rolled steel	0.22
2 hollow set-screws	0.05
⅛-inch drill rod	0.05
Fiber washer	0.05
Cost of making drawing	5.00
Cost of machine work, 22 hours at 40 cents	8.80
Cost of hand work, 4 hours at 40 cents	1.60
Cost of power, 15 hours, 2 horse-power, at 20 cents	3.00
Total cost	$22.74
Add 10 per cent	2.27
Total cost	$25.01

* * *

SPECIAL DRAWINGS FOR THE PATTERN-MAKER

E. W. MILLER*

It is the practice of many shops in this country to make a working drawing of a casting, which suffices for both the pattern-maker and the machinist. The pattern-maker gets a blue-print and is told to go ahead with the work. From the maze of lines he picks out those meant for him, and makes the pattern, and usually he decides the amount of stock necessary for finish. At the outset, the pattern-maker loses time in distinguishing pattern dimensions from those necessary to the lathe or drill press hand. The time lost here, however, is small compared to that lost by the men who work repeatedly on this piece, and who are compelled to use a drawing bearing a lot of pattern dimensions which cannot fail to confuse. Very often, too, these drawings are made at a reduced scale. This necessitates various radii to insure the correct form for curved surfaces. All this adds to the confusion.

At the works of the Fellows Gear Shaper Company special drawings are made for the pattern-maker. These are full size and the amount of finish is decided in the drafting room. No blue-print is furnished, but a buff paper drawing is made, and when the pattern is completed, the drawing is indexed and placed on file. This method has the following advantages: The full-size drawing gives the draftsman a better idea of proportions. By making the pattern drawing first and using this together with the assembly drawing when making details for the shop, the chance of error is much reduced. This is because a pattern drawing must be more thoroughly developed than a shop drawing. The making of several sections and an elevation or two not necessary to the machinist, often brings to light interferences which would otherwise escape notice.

It might be said that the other method of making combined drawings would accomplish this. It is, however, impracticable to make such pattern drawings as complete as they should be. The difficulties of the machinist increase as those of the pattern-maker diminish, so at best it is a compromise. It is the lot of the pattern-maker to form many irregular curves. When the drawing is full size, he may prick through the paper and define a line on a thin board which, when cut to the line, is a correct templet for the curve. This is easily done, requires little time, and is more accurate than a curve formed by laying out parts of circles from radii given.

* * *

More than 56,000,000 gallons of creosote and nearly 19,000,000 pounds of zinc chloride were used in preserving timber in the United States last year. Small quantities of crude oil, corrosive sublimate, and other chemicals were also used. These figures are based upon reports to the United States Forest Service of forty-four firms which operated sixty-four timber treating plants. Assuming that on an average one gallon of creosote, or one-third of a pound of zinc chloride, will protect a cubic foot of timber from decay, more than 100,000,000 cubic feet of cross-ties, piling, poles, mine, and other timbers were given a treatment that will greatly increase their life and usefulness.

* Address: Fellows Gear Shaper Co., Springfield, Vt.

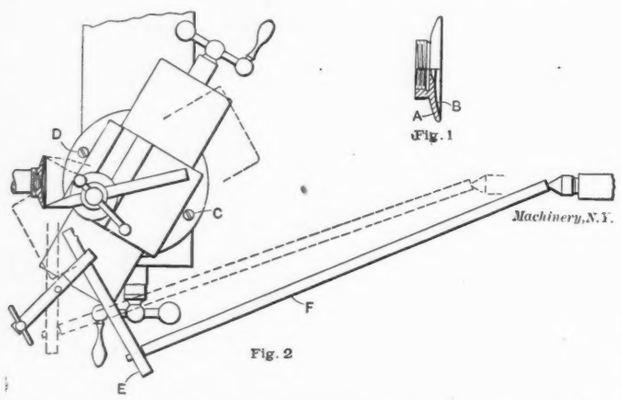
LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

SPHERICAL TURNING WITH COMPOUND REST

The brass casting, Fig. 1, is part of an eyepiece for a small telescope, of which a number were to be made at one time. The curved surfaces, *A* and *B*, while not very particular as to shape and size, would look much better if smooth turned, so it was decided to turn these surfaces with a spherical turning rig and let them go with a good tool finish, rather than to turn them with a hand tool and polish with emery paper afterwards.

Fig. 2 shows how the concave spherical surface was turned. The cross-slide of the compound rest was so set that the swivel pin was directly under the line of centers of the



Figs. 1 and 2. Eyepiece for Telescope, and Lathe arranged to turn its Spherical Surfaces

lathe, and the rest was set at such a point on the bed that the distance, horizontally, between the swivel pin and the work, was equal to the desired radius of the surface *B*, Fig. 1. Then by slightly loosening the two screws, *C* and *D*, the top slide could be turned on the swivel pin, which would cause the point of the turning tool to travel in an arc of a circle. It was at first intended to simply grasp the top slide in the hands, and turn it that way, but it could not be moved steadily enough, as it would move by jumps, and leave ridges in the work. The square bar *E* was then clamped to the top slide, and the round bar *F* placed between the outer end of *E* and the tailstock center. Then, by turning the tailstock screw, a smooth, even motion could be given to make the point of the cutting tool travel in the arc of a circle, and produce a good finish on the work. The bar *F* has a shoulder turned on one end that fits loosely in a hole in the outer end of *E*, while the other end of *F* is centered in the ordinary manner. This leaves the top slide of the rest free to be used to feed in for the depth of cut.

It is a comparatively easy matter to adjust the cross-slide so that the swivel pin is in line with the lathe centers. If it is too far forward, the tool will not touch the finished surface when moved around towards the back, as shown dotted in Fig. 2, or if the swivel pin is too far back, the tool will jam into the work when moved to the dotted position. A good way to make this adjustment, is to set the swivel pin at approximately its proper position, preferably a little too far back, and take a light spherical cut near the edge of the rim. Then by placing a test indicator in the tool-post, and swiveling the top slide so the test indicator point bears alternately at the front and back, the cross-slide can be adjusted so the test indicator reads the same in both its front and back positions, when the swivel pin will be properly located, crosswise of the lathe, to turn an accurate spherical surface.

The convex spherical surface *A*, Fig. 1, was turned in much the same manner, only a bent left-hand side tool was used, and the top slide of the rest was nearer to the end of its travel. In this case the bar *E* was not necessary, as *F* could then bear directly against the back end of the lathe tool.

As a matter of fact, two clamps were used to clamp *E* to the top slide, but only one is shown to avoid confusion, and also to make it a little easier for the draftsman and the engraver.

WALTER GRIBBEN.

Brooklyn, N. Y.

STRIPPING CUP-SHAPED DRAWN PIECES AND BLANKS THAT ADHERE TO PUNCHES

Die work, as all enterprising mechanics are aware, is to-day playing one of the chief parts in the manufacturing business, and with all its broad possibilities we are continually striving to perfect the most minute, troublesome details to the fool-proof and break-proof basis, thereby bringing out the speed and output, for, as we all realize, every time a stroke of the press is halted there is time and output lost.

In the first place, it goes without saying that in the drawing of all punch pieces there must necessarily be a die-shedder to throw the drafted punchings out of the die, but this is by no means the complete solution of the proposition. Every die-maker or press hand is acquainted with the troublesome, disastrous effect of having the drawn and punched pieces cling long enough to the shedder for the press to come down on a new piece of stock and the punching just made. The outcome is generally a broken die. Of course many thousand may be drawn without any mishap, especially if none or little oil is used on the stock, but without oil the life of the drawing die is soon spent, or in the event of copper or brass being used, the metal amalgamates and necessitates taking down the die to remove the amalgamated stock. In our particular case nothing short of diamond powder would remove the stock

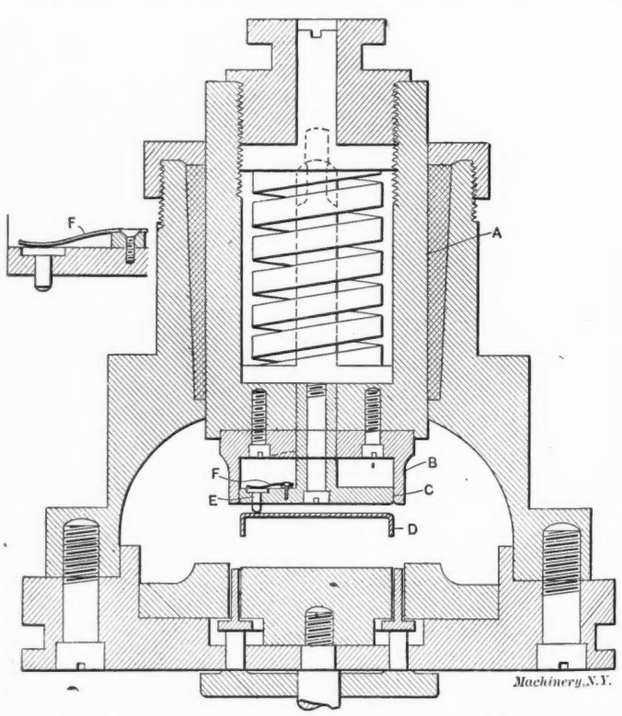


Fig. 1. Sub-press Die equipped with a Secondary Knock-off Pin E

from the die and, of course, the cost of this powder all added up in the expense account. When we undertook to put enough oil on the stock to keep the dies in condition, the cups or punchings would invariably adhere to the pushout shedder from oil contact; therefore, we were compelled to punch one at a time, pushing them loose from the shedder each time. After considerable figuring and experimenting, I arrived at a complete solution which has saved us many dollars in die repairs.

The cast iron piston of a sub-press die is represented by *A* (Fig. 1), while *B* is the hardened drawing die, and *C* the internal die-shedder for pushing the drawn pieces from the die.

Now, as mentioned before, the cup *D* would cling by oil contact to the shedder *C*, but by means of the secondary knock-off pin *E*, with a flat spring *F* to operate it (see enlarged view), as soon as the cup is pushed from the drawing die the pin *E* has the tension supplied to it by the spring to break any oil contact that may exist, thereby causing the cup to drop immediately down into the punched hole in the running stock, to be drawn forward out of the way of the succeeding punching. By recessing a spring receptacle, the spring *F* and pin *E* consumed no additional space between the die and shedder. This scheme which has just been brought about by me and is truly original as far as we know, has enabled us to increase our speed from 1,500 to 4,500 an hour. The particular punchings in question are of brass and are 1¾ inch diameter, ⅜ inch high, and 0.02 inch thick. We are now running from 25,000 to 35,000 without even touching the dies for repair.

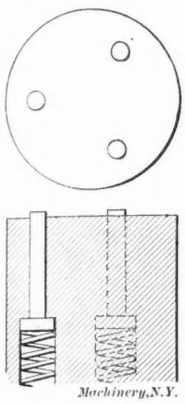


Fig. 2. Punch with Spring-actuated Push-pins to shed Blanks

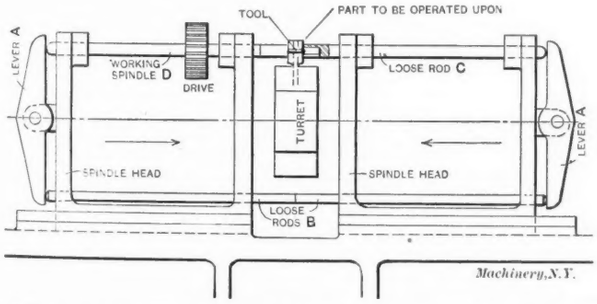
This scheme has been applied to many flat compound punchings of copper when the center punching has a strong tendency to draw up and stick on the center punch. One instance is that of a copper washer 0.015 inch thick, 1 inch diameter, with ½ inch hole. When blanking sheet copper the die does not seem to be able to shed the punching which invariably comes up after being punched; this, of course, puts two thicknesses of metal between the dies for the succeeding punching, then, by running both punchings, three deflecting pins in the punch with coil springs back of them, as shown in Fig. 2, end the trouble.

C. Howell Dockson.

Springfield, Ill.

PRESSURE COMPENSATING DEVICE FOR AUTOMATIC MACHINE

When a fixture cannot be built strong enough to resist the pressure of the cutting tool, or when the surface of the part to be operated upon cannot be properly supported, the compensating device, shown diagrammatically in the engraving, may be used to advantage for equalizing the pressure on the part, due to the thrust of the cut. This illustration represents an unusual arrangement of an automatic turret machine. At either end there are levers *A*, fulcrumed in the center as shown, which can be put into any position. The levers *A* are so arranged that they are in line with the work-spindle *D*, the rod *C*, and the two lower rods *B*. As the spindle heads move toward the work, there is no appreciable pressure upon the



A Device for Automatic Machines, designed to equalize the Pressure, due to the Thrust of the Cut, upon Work which cannot be properly supported

latter when the spindle *D* or the rod *C* comes into contact with it, until rods *B* meet as shown in the illustration. Then the work is subjected to the pressure of the tool, but the former is supported on the other side by rod *C* with the same amount of pressure as that due to the thrust of the cut. There are doubtless a large number of cases in which this system of equalizing levers can be used to advantage, particularly when the same part is being manufactured in large quantities, such as small rods, links of threshing machines, small parts of sewing machines, etc. Of course, these parts would first be roughed off on the sides by planing or milling. All other operations such as drilling, finish facing, counterboring, counter-sinking and reaming can be accomplished by using the device here illustrated. Other parts such as fly-wheels, valve seats, etc., which cannot be securely fastened by their peripheries, can also be drilled, chamfered, reamed, counterbored and even ground and polished by the use of the equalizing levers.

Elizabeth, N. J. Peter Zulinke.

COMBINATION LOCATING, CLAMPING, DRILLING AND COUNTERBORING TOOL

I have noticed in my travels among the manufacturing plants that many are wasting time by using poor jigs and fixtures. Some will acknowledge that they use poor tools, and the excuse offered is that there is not enough time lost to pay for better ones, but this is rather a poor argument.

The plan view of the drilling fixture shown in Fig. 1 is one that I saw on one of my recent visits to New York City, and this fixture is a fair illustration of the point in mind. The locating of the work was accomplished by the two screws *B* and the pin *A*, and the three clamps on pads *C* held it in place.

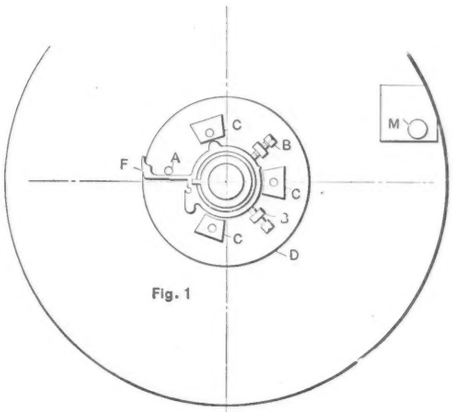


Fig. 1

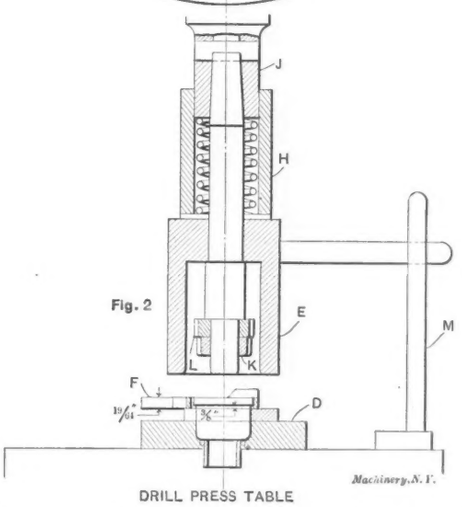


Fig. 2

A Tool for the Drill Press which locates the Work and then holds it for the Drilling and Boring Operations

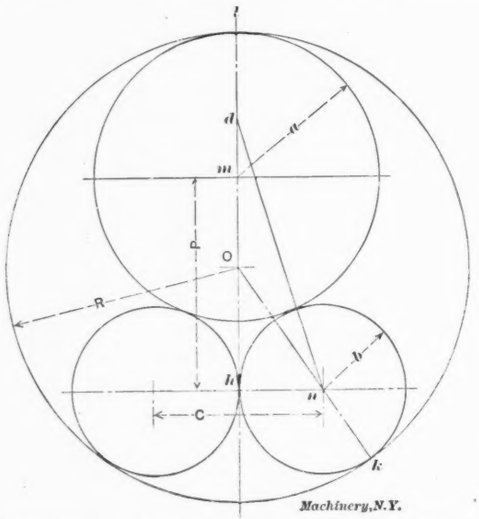
With this fixture the operator machined about 300 finished castings per day. With the improved tool shown in Fig. 2, some 1,000 finished castings constituted a day's work—a gain that well paid for the building of the improved device. This is a combination tool for locating, clamping, drilling and counterboring the work. In constructing this tool the old fixture minus the clamps was retained. This part is located in a central position on the top of the drilling press table, and the three locating points *B* are used to center the casting with the sleeve *E* that surrounds the counterbore, which is held in the spindle by its taper shank. This cylindrical bushing *E* is bored a little smaller in diameter than the outside of the casting *F*, and the mouth of the bore is flared out in a bell-shape as shown. The lower face of the sleeve is cut away in places in order to clear the projections on the casting to be machined. The top part of the sleeve is bored to a running fit for the shank of the counterbore in order to bring it into alignment with the cutters. A machine steel pin prevents the bush-

ing from revolving out of position. Within the tube *H*, which is a sliding fit on the spindle *J*, there is a steel wire spring which keeps the bushing *E* against the shoulder on the end of the counterbore. This spring also holds the casting down in the jig when the cutters are at work. On the end of the counterbore there is a pilot which enters the bushing which is placed in the center of the fixture *D*, just before drilling takes place, and keeps the counterbore rigid. The casting *F* is drilled and counterbored in one operation by two cutters *K* and *L*. Cutter *K*, which bores the through hole, has a rounded end, while the cutter *L*, which does the counterboring, has a square end. When using this tool, the drill-spindle handwheel is equipped with a long lever, which enables the operator to move the tool rapidly to and from the work. In the face of the drill press table a vertical stud *M* is placed, which acts as a stop and prevents the locating and clamping bushing from moving past its correct position. F. W. HALL.

Berlin, N. J.

DETERMINING THE DIAMETER OF A CIRCUMSCRIBED CIRCLE

On the "How and Why" page of the May number of MACHINERY, the problem given by "J. F. P." of finding the radius *R* (see diagram) when distances *P* and *C* are given, has a different solution from the one that I recently worked out for a similar problem, which is as follows: First find the radius *a*



The Problem is to determine the Radius R when the Dimensions P and C are given

by the method given in the solution referred to; as there stated $a = mn - b$, but $mn = \sqrt{mh^2 + hn^2} = \sqrt{P^2 + (\frac{1}{2}C)^2}$.

Next, lay out a distance *ld* equal to the radius *b*. Then *dh* equals $mh + md$ or $P + md$. (md equals the difference between *lm* and *b*.) Tangent angle *hdn* equals $\frac{hn}{dh}$. Angle *hOn* equals 2 × angle *hdn*. *On* equals cosecant angle *hOn* × *hn*. Then *R* equals $On + nk$.

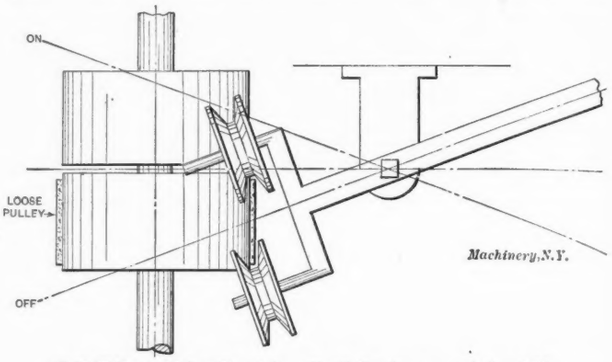
This solution, dealing with trigonometry, may not be as readily understood by some as the one given in the May number, but to one working with angles every day it is much simpler than the one using the algebraic equation.

Ilion, N. Y. A. C. JOHNSON.

IMPROVED FORM OF BELT SHIFTER

A 4-inch crossed belt driving one of our grinders annoyed us by turning over when shifted, and remaining so until, after half a dozen twists were in, it had to be run off the pulleys and straightened. In its twisted condition, the belt was more or less unevenly strained, and when the joint passed through the fork additional chafing was produced that not infrequently pulled out the hooks and disconnected the belt. The grinder was of the type built with the counter-shaft on the base at the rear and served by a shipper-lever that reached forward to a position convenient to the foot. An ordinary iron fork straddled the belt, and, as the machine was started many times an hour by the "approved" method of starting, which was to give the lever a vigorous kick, the time spent in keeping the belt in shape can be surmised.

To "cut out" all this waste time, a new fork was made having turned ends on which were mounted deeply grooved guide rollers between which the belt ran. Thus protected,



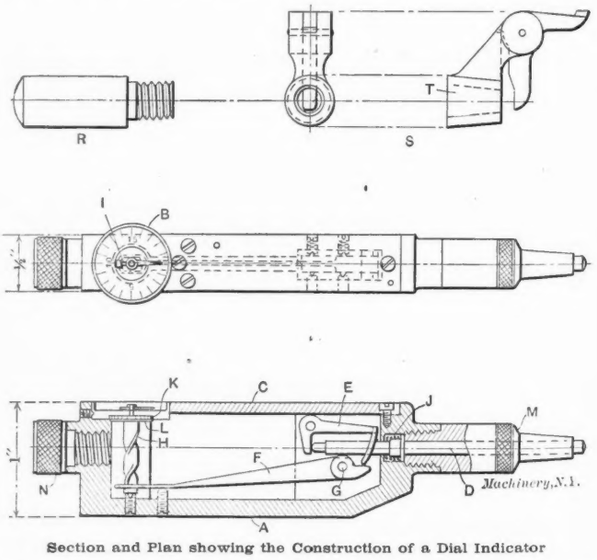
Belt Shifter which will not turn the Belt when operated quickly

no amount of kicking at the lever could twist the belt which, being in contact with rolling surfaces only, was not abraded. It will be noticed from the engraving that the rollers never lie in the same plane except when the belt is half on each pulley; they are confined on the forks only by the belt with which they are free to move endways, stop collars not being necessary. These rollers are made of maple, treated to two coats of filler, it being considered better to replace a pair of such inexpensive rollers once a year than to use metal ones which would demand careful lubrication.

Middletown, N. Y. DONALD A. HAMPSON.

COMPACT FORM OF DIAL INDICATOR

A compact form of dial indicator for use on external and internal work is shown in the accompanying engraving. The working principle of this tool, which was also illustrated in the April number of MACHINERY, is as follows: The rod *D*, which is in contact with the work being tested, when forced back strikes the lower arm of lever *E*, while at the same time the upper arm of this lever, in which there is an elongated slot through which rod *D* passes, strikes the fork lever *F*, which causes it to swing on the fulcrum pin *G*. On the



Section and Plan showing the Construction of a Dial Indicator

long end of this lever there is likewise an elongated slot, that is an exact sliding fit on the flat of the spiral lead-screw *H*. This screw is supported at the upper and lower ends similarly to the pinion shaft of a watch, and rotates on its centers freely without any perceptible jar or friction. As the slotted end of the fork lever *F* is raised it engages with the spiral or thread of the screw *H* and causes it to revolve. At the top of screw *H* is fastened pointer *I* which gives the reading.

To bring the levers, screw and rod *D* back to their original position, there is a fine wire spring *J* in the head of body *A* that rests against the shoulder on rod *D*, and there is also a watch hair spring *K*, one end of which is fastened to spiral screw *H* and the other end to the dial *B*. Underneath this spring there is a copper washer *L*, which prevents lever *F* from striking the spring. Both of these springs should be so adjusted as to bring back their respective parts to the normal position without any further unnecessary tension, because if these springs are made heavy and a high tension put on them, it will be found that the bearings, etc., of the different levers will soon wear, and therefore the accuracy of the indicator will be lost.

The body *A*, dial *B* and cover *C* may be made of some good grade of cold drawn steel, and all other parts of a high grade tool steel, and hardened. When filing the end of lever *F*, extreme care should be taken in forming it to the proper curve, to compensate for the loss and increased movement at the point where lever *E* bears against it. It is very important that all levers have a free oscillating movement, that all pinion screws are carefully adjusted and that they are a snug fit in their respective tapped holes.

The part *R* is a tail piece or an extra attachment to go with the indicator; this is used to take the place of part *N* when it is found necessary, for instance, to use the indicator in the lathe, in which case it can readily be caught in a boring tool holder. The part *S* is also an extra attachment, and it can be readily attached to the taper end of nose piece *M*. This attachment is used when it is desired to use the indicator to obtain inside measurements. The taper hole *T* should correspond with taper on the nose piece *M*, which is about 1½-inch taper per foot. The lever should work freely without any perceptible vibration, and should be hardened.

Buffalo, N. Y. LUCIEN HAAS.

AIR BLAST ON THE PUNCH PRESS

An arrangement for blowing work from a forming die in a punch press, by means of compressed air, is shown in Fig. 1. It is simple and durable, and is used on about forty presses

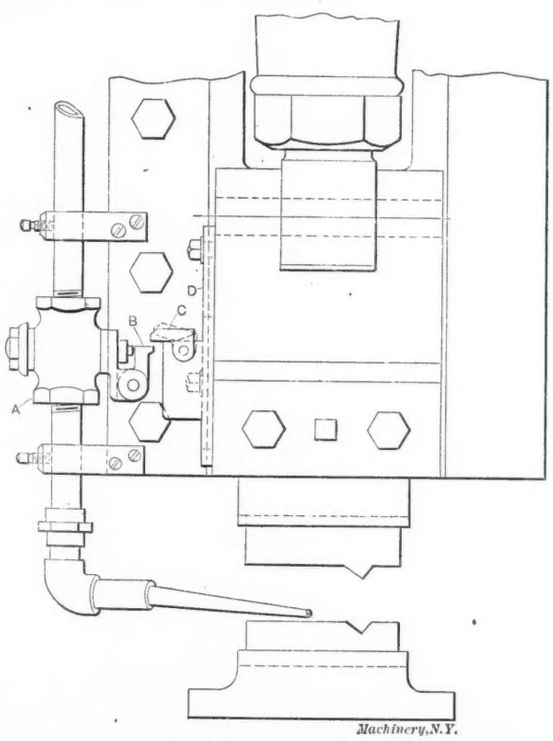
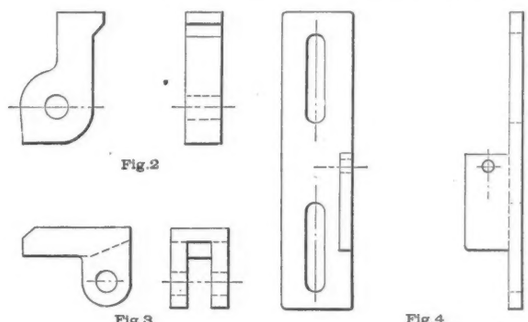


Fig. 1. Pneumatic Punch Press Attachment which automatically removes the Work

in a large plant, with satisfactory results. The engraving shows a plain forming die in position under the plunger of a press, while at the left of the plunger is the air valve *A* with its attachments. This valve is a Lunkenheimer whistle valve. It is held by the pipes which are screwed into each end, these pipes being held by the brackets which are screwed to the frame of the press. Below the valve there is a union and some other connections, and a bent tube which may be turned so as to apply the jet of air most advantageously. In some cases two unions are used to facilitate the adjustments. The lever of the whistle valve has been removed and in its place the trigger *B*, which is shown in detail in Fig. 2, is mounted. This trigger is so designed that it remains vertical when not in action; it is seen in position against the plunger of the valve. The trigger is operated by the pawl *C*, shown in detail in Fig. 3, which is mounted on the bracket *D* shown in Fig. 4. The bracket is made of angle iron and is provided with two long slots for adjustment when the dies vary in thickness. It is held by two screws which are tapped into the plunger.



Figs. 2 to 4. Some of the Details of the Attachment

As the plunger descends, the end of the pawl *C* rises, as shown by the dotted outline, and passes below the head of the trigger *B*. On the upward stroke the end of the pawl engages the cam on the end of the trigger and thus operates the valve. In this way a jet under full pressure is suddenly directed against the work, blowing it out of the operator's way before the plunger reaches its highest position. When we realize that more time is usually consumed in removing the pieces by hand, than in placing them in position, the saving of time is appreciated.

The same device may be used to advantage for removing dry chips from a vise on a milling machine when doing light work. Often the operator wastes more time in brushing away chips than in doing the actual work. The valve may be clamped to the column of the machine and operated by a slight extra movement of the table. The writer has also adapted the scheme with success to a drill press used to drill wood, on which the table moves.

Camden, N. J. HERBERT C. BARNES.

WHAT WOULD JIM HAVE SAID?

The answer given "F. O.," who asked for a general rule for locating a driving and driven pulley on shafts not parallel, in the May number of MACHINERY, brought before my mind an incident that occurred when Jim and I were employed in a small shop a few years ago. We had a superintendent whose load of wisdom was manifestly all he ought to carry, and no one who knew him would willingly attempt to add to his burden in that line. It was desired to move a machine around at an angle to the main shaft, so the "super" squinted around a little and told Jim to stand the counter on some marks on the floor which he had made. The belt ran off as fast as they tried to put it on, and after that the "super" kept Jim pinching that heavy counter-shaft around the floor for two days trying to find the place where it could be located and have the belt run on the pulleys. Meanwhile the rest of us, who worked by the piece, were waiting for the stock to be put through that machine. Now the "super" (who had brought up one family) had just taken unto himself a new wife and she used to send for him to come home and see her once or twice every day. It was one of these absences that gave us a chance to use the rule given us by an old millwright for belting a machine that was placed at an angle with the line shaft. So when the word went around that the "super" had had a "summons," we went out to see if we could not get that machine to run without his knowing how we did it. Jim's disgust was apparent on his face and more so in his remarks, but he was good for one more try,

and when we said, "Plumb the centers of the delivering faces," Jim understood, and we stayed with him and helped lace the belt so that the "super" would think it just happened to come right.

The answer given "F. O." made me wonder what Jim would have said if someone could have handed him that rule. I imagine he might have read as far as the word tangent and then said, "Tangent to your grandmother," or something more forcible, and then gone on pinching that counter-shaft around to the next trial location. The rule referred to is complete and not very obscure, but I will venture to assert that not one in ten of the better class of men in the shops will understand it without some help. I suppose there are a great many homely rules, which were used before the present generation of mechanics came on the stage, that are just as easily understood as the one given in the foregoing, and if they could be rounded up and written down, would help some one over a hard spot. Who has another? C. A. H.

SOME MILLING MACHINE DETAILS

Times were bad—nothing doing—and our equipment of milling machines was nearly as bad as the times, so we decided to build a couple of millers for our own use. Drawings and patterns were made, and the machines pushed on as rapidly as possible. The drive, as originally designed, was by a three-speed cone, back gears, and a two-speed counter giving twelve speeds to the spindles. After careful consideration and a little figuring, we decided to alter the drive to double back gears. Unfortunately, before we arrived at this decision the body castings had been made so that we had to be content with a two-speed cone in place of the three-speed one, but as this (with the double back gear and two-speed counter) also gave us twelve spindle speeds, we were quite satisfied, though we had to do a moderate amount of extra chipping, facing, etc., to get the new arrangement into the place designed for the old one.

One of my reasons for writing this is to show what a great advantage double back gears have over the ordinary single

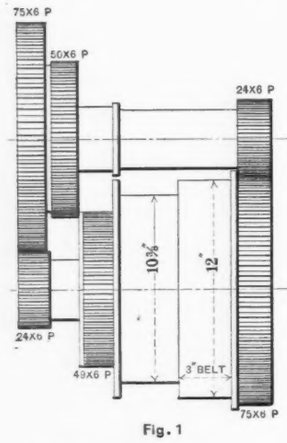


Fig. 1

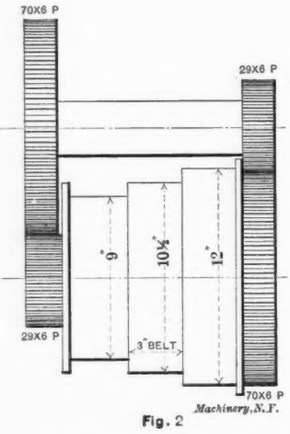


Fig. 2

Fig. 1 Double Back Gear Fig. 2. Single Back Gear

back gear. Perhaps some readers who are concerned with millers or other cone and single back gear machines will be tempted to alter their drives to the double back gear type—at any rate I should certainly advise them so to do—for in my opinion double back gears are only slightly removed from the constant speed or gear box drives now coming into use and are not by any means so expensive.

Fig. 1 shows diagrammatically the two-speed cone and double back gears, and Fig. 2 the three-speed cone and single back gears which were discarded. There are two methods by which we may compare the power of the two arrangements: First by finding the average horse-power transmittable by the cone belt, and second by comparing the average belt and gear purchase. As the first is the shorter method we will apply it here. In any cone drive the horse-power transmitted by the belt varies through more or less wide limits, because as the speeds are varied the belt is working on a larger or smaller step of the counter cone, with the result that the horse-power varies as the diameters of the cone speeds and also (in the case of a two-speed counter) as the counter speeds vary. If, then, we find the horse-power for each belt speed and divide the sums of these quantities by the number of belt speeds, we shall have the average horse-power. The formula for obtaining the horse-power transmitted by a belt is H. P. $= \frac{D \times \pi \times W \times S \times 40}{33{,}000}$, where $D =$ diameter of pulley in feet, $\pi = 3.1416$, $W =$ width of belt in inches, $S =$ revolutions per minute of pulley, $40 =$ pull of belt in pounds per inch of width.

It was found that the average power transmitted by the double back gear drive was 30 per cent more than for the single gears. By comparing the two by the second method, that is, by the average belt and gear purchase, the double back gears make a still better showing.

The formula for this method is $D \times R \times W$, where $D =$ diameter of cone step, $R =$ ratio of gears, $W =$ width of belt. Since in this case W is the same for both examples, it may

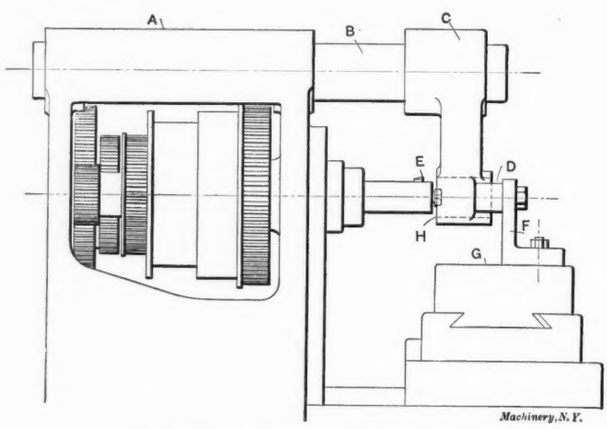


Fig. 3. Method of Boring Overhanging Arm

be left out and $D \times R$ used as the formula. If this is worked out for each spindle speed and the average taken as before, we find that the double gear arrangement is more powerful by 40 per cent.

Another valuable feature of double back gears is the comparatively high spindle speeds obtainable through the gearing; this is a very important item in these days of heavy cutting at high speed.

With each machine there is a blue-print table, which gives the spindle speeds, how each speed is obtained, feeds and how obtained, suitable sizes of cutters for each spindle speed at various cutting speeds, and feed per minute for each speed at any one of the fifteen feeds. By this means the operator knows exactly what he is doing; or, what is perhaps even more important, how to get what he wishes to get without any reference to a stop-watch, cut meter or other similar instrument.

I might say in concluding this rather long eulogy of double back gears that we have taken a cut ⅜ inch deep off a piece of cast iron 3½ inches wide at a cutting speed of 50 feet and a feed of 3 inches per minute. The cutter was 8 inches in diameter and was screwed onto the spindle nose, which had eighteen inserted high speed steel cutters.

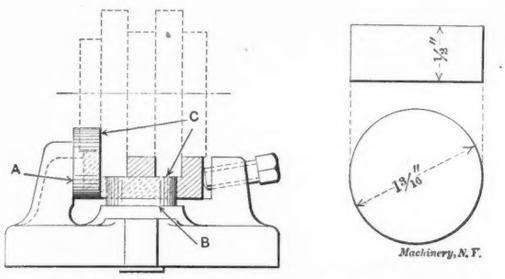
One little detail of construction may prove of interest and that is the method we adopted of boring the arbor bearing in the outer support. This had been previously bored in the lathe, but when we tested it we found that the bearing was considerably out of line with the spindle, so, to insure an accurate job, we rebored it by the method shown in Fig. 3. The outer support C was firmly clamped to the overhanging arm B and the latter was adjusted to its bearing A (by means of the clamp bolts), so that it was a close sliding fit.

The angle plate F was bolted to the table G and also to the brace lug D, care being taken to have the bearing H as nearly in line with the spindle as its inaccuracy would permit. A boring tool E mounted in the taper hole of the spindle completed the outfit, the bearing H being trued up with one roughing and one finishing cut with the regular automatic cross feed for feeding. This made a very good job and one that couldn't

be anything else but accurate. Another method of overcoming error in the bearing of the outer support is to make the bush which fits the hole *H* slightly eccentric so that it may be adjusted to the proper center; but our method is thought to be much better as the bush is then a plain straightforward job easy to replace when worn. RACQUET.

LOCATING TOOLS AND CUTTERS IN PLANING AND MILLING FIXTURES

As one who has had considerable experience with fixtures for planing and milling, I would like to condemn the common practice of providing fixed locating faces, to which tools and cutters should be set directly when machining the pieces held in the fixtures. My experience has shown that sooner or later these locating faces become damaged by contact with the tools, through carelessness or otherwise. A much better practice is to provide locating faces set back from the line of the tool point or face by a certain amount, say ½ inch, so that



Method of Locating Cutters in Correct Relation to Finished Surfaces on a Fixture

a standard height block can be inserted between this locating face and the tool. The block is held by hand when setting the tool or fixture until it just touches both the locating face and the tool. By this means a very sensitive adjustment can be made and the locating faces preserved. One of the height blocks, and also its method of application, is shown in the accompanying engraving, in which *A* and *B* represent two locating faces, and *C* the ½-inch blocks locating a milling cutter sideways and for height. HEIGHT BLOCK.

TWO BENDING DEVICES

In the manufacture of gasoline lamps on a small scale, a jobbing shop uses two bending jigs that may be of interest. The upper part of the framework of the lamp is made of rather heavy brass tubing about a quarter of an inch outside diameter, bent as shown in Fig. 1. This tubing is bent with the tool shown at the left in the engraving. When in use it

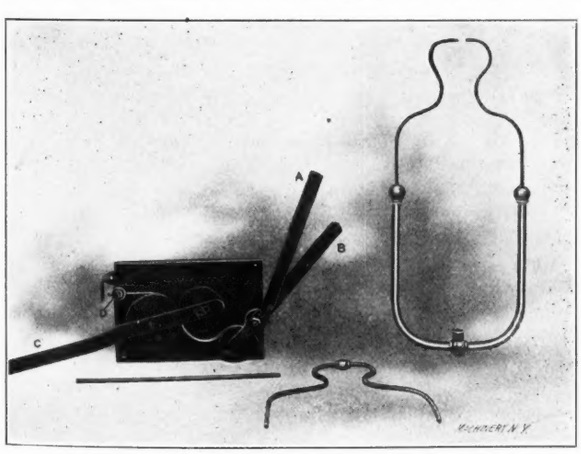


Fig. 1. Tool of Simple Construction for Bending Brass Tubing

is screwed flat on the bench, near one corner, where the handles may be easily worked. The levers *A* and *B* and the attached roller are slipped off the pivot pin and a piece of tube of the proper length is passed between the roller on lever *C* and the first former, through the hole in the post *D* and against the stop shown. The lever *C* is then pulled around, bending the tube over onto the second former. The levers *A* and *B* are then slipped on and the final bend is finished. The two levers *A* and *B* are used for adjusting purposes. The tubing is heavy enough to bend nicely without filling, the rollers being, of course, grooved the size of the tubing.

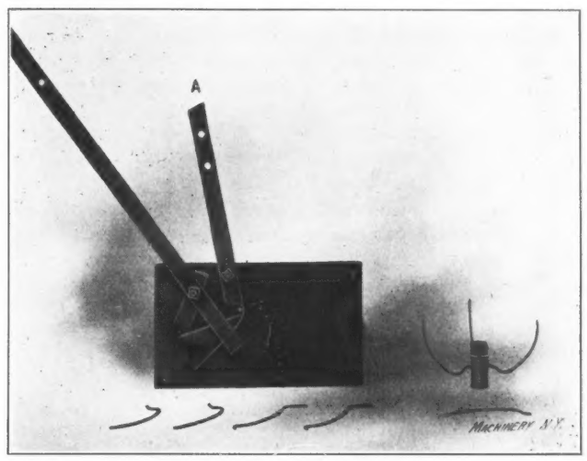
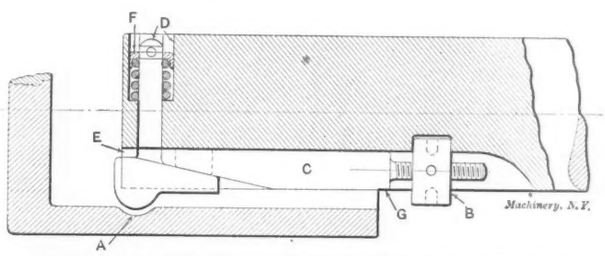


Fig. 2. Device for Bending the Wires shown in the Illustration

Fig. 2 shows the tool for bending the wires used to hold the glass globes in place. In order to get the little kink in the end of the wire, a hole is drilled in the end of lever *A*, into which the end of the wire is slipped while the end of the other lever is up as far as possible. Lever *A* is then pulled up against the stop-pin and held there while the bend is finished with the other lever. E. V.

ADJUSTABLE BORING TOOL FOR TURRET LATHE

To effectively accomplish all the work of the turret lathe with the general line of tools with which a machine is equipped is impossible; some form of boring-tool which can be adjusted without altering the position of the turret head will often be of value. There are many types of this class of tool, some of which are altogether too flimsy to be used when heavy cuts are necessary. The tool illustrated herewith is



Recessing Tool which may be fed into the Work without Changing the Position of the Turret

stiff and rigid, and, consequently, it can be used on heavy cuts. The illustration shows a part section of a casting, the bore of which was first machined with the bars in the turret. The special adjustable boring-tool is used to form the recess shown at *A*. The tool is adjusted to the proper position in the bore as shown, and then it is fed into the metal by turning the feed-nut *B* which forces the wedge-shaped feed bar *C* under it, thus giving steady feed.

When making a bar of this type care should be exercised when fitting the cutting tool, as it should be a close sliding fit in the hole *D*, and, at the same time, have a good bearing on the sides of the slot *E*. The spring shown should be strong enough to keep the tool rigidly on its seat. The cap *F* retains the spring and prevents any dust or borings from getting to the spring and tool-shank. The cutting tool is made of high-speed steel, and the feed bar *C* of mild steel with taper end case-hardened. That part of the tool-shank which passes through feed bar *C* is flattened in order to reduce the width of the slot in *C*. A thread of fine pitch on the end of the feed bar provides a slow feed to the cutting tool. The slot at right angles to the bar which receives the feed-nut *B* should

be circular, so as not to weaken the section of the bar more than is necessary. Obviously, any shape or form of cutter can be used for various classes of work, such as clearing out the cast recess in the combustion chambers of automobile cylinders, etc. Needless to say, the slot and feed bar must be long enough to allow the feed-nut to be outside the bore of the work being operated open, so that the nut can be turned readily. Lines can be scribed on the edge of the feed-bar slot, as at *G*, to indicate the exact position of the cutting tool and when the required depth of cut has been reached.

CONTRIBUTOR.

SHEARING PUNCH AND DIE

We received an order in a tool job shop to make about fifty shearing punches and dies that were required to make about as many different size blanks. Extreme accuracy as to dimensions was not specified or necessary, but nicely cut laminations were insisted upon. The design submitted had been carefully worked out for a tool that would last a long time and produce an immense number of punchings before having

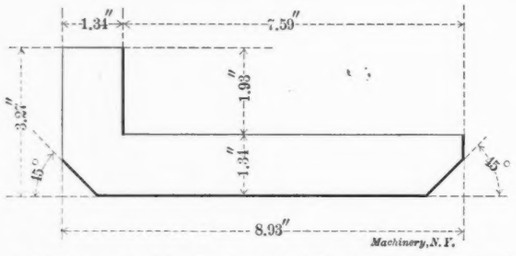


Fig. 1. Blank produced by the Punch and Die shown in Figs. 2 and 3

to be replaced. The first consideration, that will be apparent to all, in the design of this die is rigidity. The die-holder, it will be noticed, is massive and well laid out to firmly support the steel members and lessen the liability of springing during the action of cutting and causing premature wearing away of the cutting edges. The stock used for the lamination is 1/64 inch sheet iron, of a brittle quality, and covered with scale that is detrimental to a keen-edged tool or sharp corners. For

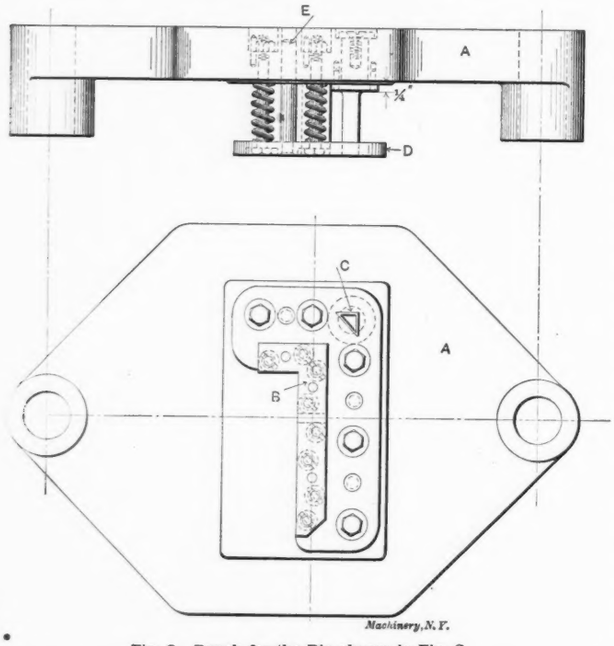


Fig. 2. Punch for the Die shown in Fig. 3

this type of die, in order to obtain the most satisfactory results, extra hard steel is of special importance, while for the piercing punch, hardness should be combined, as far as possible, with toughness, to insure the acute edges standing up.

The outline of the blank is shown in Fig. 1, and the punch and die are illustrated in Figs. 2 and 3, respectively. By careful reference to the drawings, the construction will be understood. In Fig. 2, *A* represents the cast-iron punch holder; *B* the shearing punch secured to the holder by screws and pins; and *C* the piercing punch that cuts away the corner of the lamination. The combined stripper and stock-holding plate *D*, made of machine steel, is moved downward by compression springs and maintained in place by screws and nuts as shown. Pins *E* are provided to steady this plate, as it is not very closely fitted to the punch. A clearance of 1/32 inch is given around the piercing punch to avoid springing this member, should the stripper cramp.

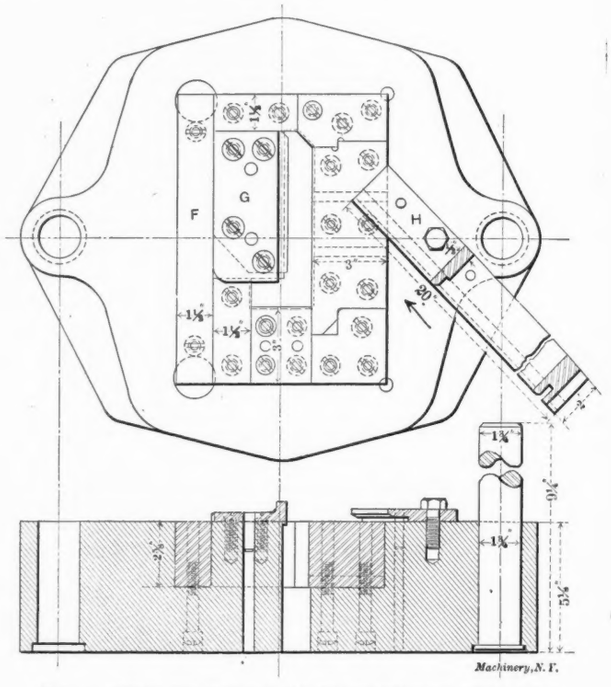


Fig. 3. Section and Plan of a Die for producing the Blank, Fig. 1

In Fig. 3 the manner of arranging the parts is clearly shown. The box-shaped holder is carefully planed to receive the six steel sections that, when assembled as indicated, comprise the working parts that do the piercing of the stock and the shearing away of the blank. The machine steel bar *F* fills in a cavity that is first machined out to allow clearance for the planer tool when working out the inside. The backing plate *G*, as will be seen, is secured to the face of the holder by screws and dowels; this member acts as a stop for the stock and also supports the punch and prevents it from springing away from the cutting edge of the die. A machine steel guide *H* for the stock is fastened to the die, and like the backing plate, has to be removed when sharpening is necessary. The punch and die are sub-pressed with 1¾-inch pins, for without these die-aligning studs the setting of such heavy tools in a press becomes a time-consuming operation, while with them it is only a matter of a few minutes. No clearance is given in the die, except on the three sides of the piercing hole, the blanks being almost free as soon as they are forced down in the die beyond the overhanging edge of the backing plate. The springing of such thin plates eliminates friction at the ends and permits them to drop out of the die.

Under working conditions, preparatory to shearing the blanks, the stock which rests against the back guide *H* is fed from right to left in the direction indicated by the arrow until it butts against the backing plate *G*. On the first stroke of the press, a portion of a blank is cut and a hole pierced; the second stroke either cuts off a perfect punching or a nearly complete one, according to its length. The only waste is that on the end and sides and the small triangular piercing. Owing to the shape there is considerable loss at both ends, hence sheet stock of longest length is provided. Twenty-five thousand is the average run per day, and between sharpenings fifty thousand clean cut plates free from burrs are sheared.

It may be well to call attention to the fact that the accurate size and location of the piercing punch is of utmost importance. Should this be at all out of place, notches on the inside of the laminations or sharp points at the angles will be manifest.

TOOLMAKER.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

TWO USEFUL BLACK-BOARDS

In connection with the instruction of mechanical drawing, it was necessary to use the black-board frequently, and, as the scale of the drawing was then enlarged, much mental calculation was necessary. The drawing sheets used were 13 × 17 inches, so it was thought a good plan to divide the top edge of the board, which was 48 inches in length, into 17 divisions, and a space along the left-hand edge into 13 equal divisions. These divisions were then, in turn, divided so as to represent half inches. All sketches were then easily drawn to scale, the trouble of figuring the proper black-board

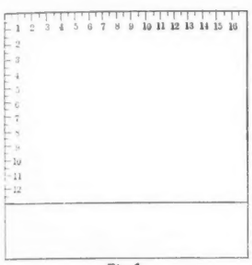


Fig. 1

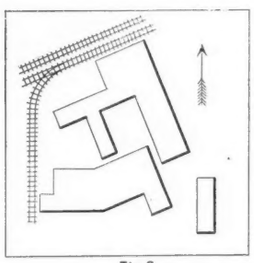
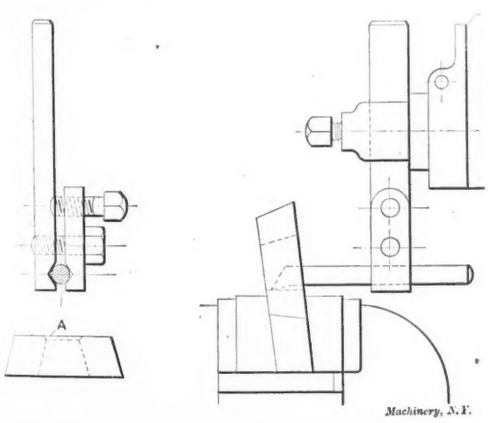


Fig. 2 *Machinery, N.Y.*

dimensions was eliminated, and, incidentally, many questions were not asked which would have been otherwise. There is space still left at the bottom of the board for any explanatory work. Fig. 2 represents a black-board, well adapted for the engineer's office. The factory grounds and buildings are permanently drawn on the board with white paint. Any suggestions regarding the changing of or additions to the plant can be conveniently sketched in, and altered without injury to the original plans. C. E. J.

ADJUSTABLE SHAPER TOOL

The tool-holder for the shaper described in the February issue of MACHINERY is very similar to one I saw a few years ago, the sketch of which is shown herewith. The tools gen-

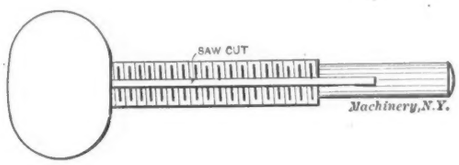


erally used were a half inch in diameter, although larger or smaller sizes could have been used as well, as will be evident by referring to the engraving. Primarily, this holder was made for planing out blanking dies, the dies being held in the vise in the manner shown. After the core was taken out, the top edge of the blank was beveled as shown at *A*, to prevent the metal from breaking out beyond the finish line.

Stamford, Conn. J. PRICE.

A THUMB-SCREW THAT WON'T JAR LOOSE

It is sometimes necessary to have a thumb-screw which can be used for adjusting purposes conveniently, that is to say, so it can be used without having to manipulate a lock-nut or other retaining device. The sketch shows a style of thumb-screw which is effective. The saw cut is put in by milling from both sides after the thread is cut, then a die is run over the threads to remove the burrs, after which a narrow thin wedge is driven into the slit which widens the threaded portion at the center. It is obvious that a screw of this kind can be easily put into place as the end is not distorted

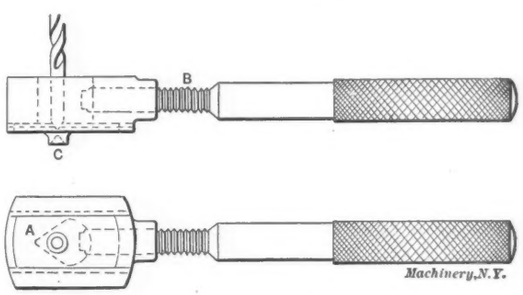


appreciably, and the compression is gradual. Ordinary malleable iron thumb-screws have enough spring to them to act well. More or less tension can be obtained by making the distortion to suit. H. R. ASH.

Chicago, Ill.

HOLDER FOR SMALL DRILLS

The tool for holding small drills, which is shown in the engraving, is very handy and convenient when small holes are being drilled in the lathe when the tail-center is used to support and guide the drill. The pointed end of the drill is placed in the center in the sliding plate *A* as shown. The

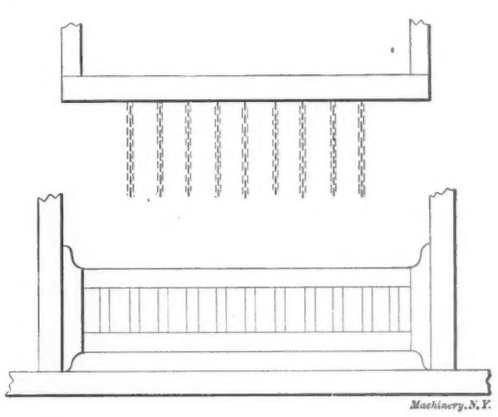


screw *B* is then tightened, and the plate follows the drill. As the center *C* is in line with the one on the inside of the plate, the result is practically the same as if there were a center in the drill. W. W. COWLES.

Poughkeepsie, N. Y.

FOREWARNING THE LOWERING OF AN ELEVATOR

Perhaps the cheapest and most convenient device used for forewarning the lowering of an elevator is shown in the engraving. A number of small chains about two feet long are hung from the bottom of the cage. If the elevator is coming down, and an attempt is made by the user to look up from the gate when the elevator is within a short distance from his head, he will have time to avoid a serious, or perhaps



fatal, accident because of the warning given by the lowering chain. [Of course it will be understood that the height of the gate is often limited by the distance between the floors.—EDITOR.] This device is in daily use in at least one factory, and doubtless if it were installed in many more, a large number of elevator accidents could be prevented. C. E. J.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

ALLOWANCE FOR "SET" OF LOCOMOTIVE PISTON RINGS IN TERMS OF DIAMETER

B. L. H.—What is the proper amount of excess diameter allowance to make in turning locomotive piston rings of the concentric and eccentric types? The chief engineer of our road claims that 1/32 inch allowance per inch diameter is right, but others say that this amount is excessive. The rings are 22 to 23 inches diameter, 11/16 inch wide, and 3/4 inch thick. The cast iron is of medium grade.

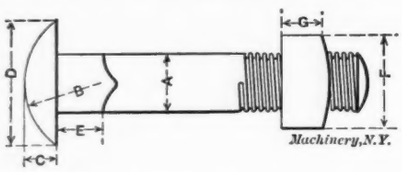
A.—The allowance for "set" made in the ordinary snap or Ramsbottom piston rings, varies considerably according to different authorities, the range being from 1 to 3 per cent of the cylinder diameter. Common practice points to about 1½ to 2 per cent in the case of narrow rings of the concentric type. In the case of a 22-inch cylinder, this would mean that the rings would be turned about 5/16 to 1/2 inch larger than the bore of the cylinder. Eccentric rings should be made with practically the same allowance but more can be given if they are sprung together after the excess is cut out and the outside turned to the cylinder diameter while held in a suitable chuck. In general there is no gain in making the allowance greater than one-half the ring depth, that is the radial dimension, for the ring will be practically worn out before the wear has equalized the "set" to the cylinder diameter.

CARRIAGE-BOLT HEADS, SHANKS AND SCREW THREADS

C. H. T.—For some time I have been searching for data on the dimensions of heads and shanks of carriage bolts, but have been unable to find any information, although I have looked over a great many standard mechanical hand-books and text-books. Kindly publish in an early issue a table giving these dimensions; also data on carriage bolt screw threads.

A.—The accompanying table giving the dimensions of heads and shanks and number of threads per inch of carriage bolts from 3/16 to 3/4 inch diameter inclusive, was supplied by the Michigan Bolt & Nut Works, Detroit, Mich., and gives the

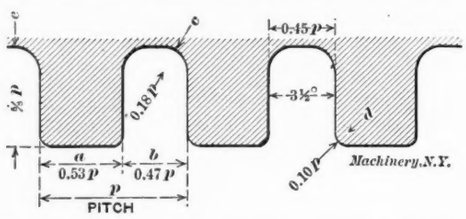
CARRIAGE-BOLT HEADS, SHANKS AND SCREW THREADS



A	B	C	D	E	No. of Threads	F	G
3/16	3/16	3/32	7/16	3/16	24	3/32	3/16
1/4	1/4	1/8	9/16	1/4	20	7/32	7/32
5/16	7/16	5/32	11/16	5/16	18	1/4	1/4
3/8	9/16	7/32	7/8	3/8	16	5/16	11/32
7/16	21/32	1/4	1	7/16	14	11/32	3/8
1/2	3/4	5/16	1 3/16	1/2	13	13/32	7/16
5/8	29/32	11/32	1 7/16	9/16	11	1	9/16
3/4	1	13/32	1 5/8	5/8	10	1 3/16	5/8

standards of this company. There is no recognized standard of carriage bolt thread. The tendency is for users to demand the United States standard thread and pitches. The typical carriage bolt thread is a sort of compromise between the Whitworth and a screw thread, but up to a few years ago hardly any two makers of carriage bolts used the same shape thread or number of threads per inch. When a manufacturer wanted new taps or dies it was necessary for him to send samples to the tap and die makers to insure perfect duplication. Some years ago the J. M. Carpenter Tap & Die Co., Pawtucket, R. I., reduced the conflicting shapes to a standard governed by the pitches of the thread, which they were able to duplicate whenever necessary without the trouble of referring to samples. This standard has been adopted by several large manufacturers of carriage bolts, but as previously stated, the tendency of users is to use the established and readily duplicated United States standard thread and pitches. The second table gives the shape and dimensions of the Philadelphia carriage-bolt screw thread, which is typical of carriage bolt screw threads in general.

PHILADELPHIA CARRIAGE-BOLT SCREW THREADS



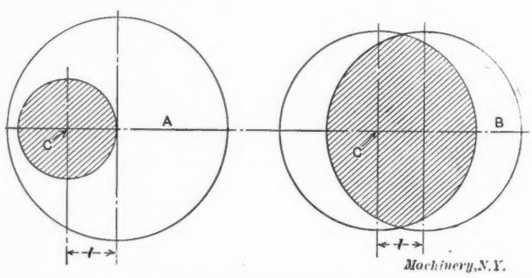
Threads per inch	e	p	a	b	c	d
26	0.024	0.03846	0.0204	0.0181	0.0069	0.0038
24	0.026	0.04167	0.0221	0.0196	0.0075	0.0042
20	0.031	0.0500	0.0265	0.0235	0.0090	0.0050
18	0.0347	0.05556	0.0294	0.0262	0.0100	0.0056
16	0.039	0.06250	0.0331	0.0294	0.0113	0.0062
14	0.0445	0.07142	0.0379	0.0335	0.0129	0.0071
12	0.052	0.08333	0.0442	0.0391	0.0150	0.0083
11	0.0568	0.09091	0.0482	0.0427	0.0164	0.0091
10	0.0625	0.1000	0.0530	0.0470	0.0180	0.0100
9	0.0695	0.11111	0.0589	0.0522	0.0200	0.0111
8	0.0780	0.1250	0.0663	0.0587	0.0225	0.0125

Contributed by "A."

ECCENTRICS AND CRANKS

R. A. B.—What is an eccentric, and when does an eccentric become a crank?

A.—An eccentric is defined as an enlarged crank-pin that encircles the shaft. There are intermediate conditions, however, that make the distinction between an eccentric and



crank not always easy. In the illustration, *A* clearly is an eccentric, and *B* may be named either an eccentric or a crank without exciting violent protest. The following points may be considered in analyzing the matter as distinguishing an eccentric from a crank: 1. Relative diameter of crank-pin and shaft. 2. Ratio of throw to diameter of shaft. 3. Whether the function is that of converting rotary action into rectilinear motion, or *vice versa*. The defining line between an eccentric and crank-pin might be assumed to be where the periphery osculates the shaft, all forms being considered eccentrics which completely encircle the shaft and all whose peripheries at any point lie between the shaft surface and its center, as being cranks. In the last, our notion would be to always limit the diameter of the crank-pin to a size not larger than the shaft and to limit *l* (one-half the throw) to not less than one-half the shaft diameter. Then, if the diameter is larger than the shaft, and *l* equals or is less than one-half its diameter, we would call it an eccentric; if the size of crank-pin is less than one-half the shaft diameter, and the throw equals or is greater than one-half the shaft diameter, we would name it a crank. According to this rule both examples shown in the illustration are eccentrics. If the function is that of converting rotary to rectilinear motion, cranks close to the limiting conditions set forth in the foregoing might be preferably named eccentrics, or, conversely, eccentrics may be called cranks. The throw of an eccentric or crank is the stroke, and is 2*l*.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

INK FOR WRITING ON CELLULOID

Ink for writing on celluloid triangles, etc., can be prepared by dissolving a tar dye stuff of the desired color in anhydrous acetic acid. JOHN B. SPERRY.

Aurora, Ill.

POLISHING WOOD

A very nice polish on wood is obtained by using the following mixture: ½ pint of alcohol, ¼ ounce of shellac, and ¼ ounce of resin. Dissolve the shellac and resin in the alcohol; then add ½ pint of linseed oil, and shake the whole mixture. Apply with a sponge, brush or flannel. Rub the wood thoroughly after the application. E. W. NORTON.

RECOLORING BRONZE

Bronze may be renovated and recolored by mixing one part muriatic acid and two parts water, and applying the diluted acid to the bronze articles with a cloth. Before applying the acid the articles should be cleaned thoroughly from all grease. After having applied the acid let the article dry, and then polish with sweet oil. E. W. NORTON.

SOLDERING PASTE FOR COPPER WIRES

Soldering paste has come into extensive use in electrical work as a flux for soldering, and the following recipe will be found useful in soldering copper wires when the use of an acid would be objectionable. This paste will not spatter or corrode, and the proportions are as follows: Saturate solution chloride of zinc, one dram; vaseline, 1½ ounce.

Philadelphia, Pa. WILLIAM DAVIS.

TO COVER IRON PULLEYS WITH RUBBER

Thoroughly clean the surface of the pulley; if the pulley has just been turned in the lathe, so much the better. Give it a thorough wash in muriatic acid and let stand over night. In the morning give the iron and rubber a good coat of heavy yellow shellac varnish and apply the rubber and clamp. Let stand until thoroughly set. E. B. GAFKEY.

Lakewood, Ohio.

SOLDERING ALUMINUM AND COPPER

It is often stated that aluminum cannot be readily and successfully soldered to other metals. I have, on numerous occasions, successfully and easily soldered aluminum to both copper and brass by the following method: First tin the aluminum and the copper, or brass, using stearine as a flux; wipe off clean, then use zinc chloride as flux, with solder composed of: tin 67 per cent, lead 33 per cent. T. ILES.

Manchester, England.

CEMENT FOR FIXING LEATHER OR PAPER TO PULLEYS

Soak six pounds of carriage glue over night; then heat until thoroughly dissolved and add six pounds of white lead ground in oil. Reduce the mixture with oil until it is of a free working consistency. Now add one ounce of nitric acid and stir until thoroughly mixed. The pulley surface should be made thoroughly clean and should be warmed to about 125 degrees F. Then apply the cement and clamp on the leather and let stand twelve hours before using. If the job is done right, the leather will have to be turned off in a lathe in order to remove it. E. B. GAFKEY.

Lakewood, Ohio.

SPOTS ON BLUE-PRINTS

We were bothered for some time with peculiar blue spots on our tracings, which were next to impossible to remove, and which caused spotted blue-prints. The office receiving these prints finally requested us to remove the ink blots from our tracings. The trouble was finally located in connection with the blue-printing. The one doing this work had a habit of making one print, washing it at once to prove the color, and then printing the entire lot. Now after washing the first print, he did not thoroughly dry his hands, and on placing the next print, the paper was moistened and the exposure "fixed" some of the blue clear through the tracing cloth.

HOWARD D. YODER.

BATH FOR HARDENING HIGH SPEED STEEL.

An excellent bath for hardening high speed steel consists of a mixture of table salt and paraffine oil, in the proportion of one pound of table salt to each gallon of pure oil. The steel is heated to a lemon color, and plunged into the bath, being kept in motion until it has thoroughly cooled. The steel should come out of this bath gray in color, and nearly free from black spots. The bath referred to can be used for almost all brands of high speed steel, with good results. It has been used to great advantage for the Midvale steel, and also on a large number of tools made of Novo, Simeteora, Rex, Jessop high-speed, and Blue Chip steel. On all these, good results have been obtained, but it may be added that this bath seems to give the best results with the Midvale steel.

H. S. STEEL.

FOR HOLDING LEATHER ON IRON PULLEYS FOR BAND SAWS

First soak twelve ounces of good glue in cold water. Put four ounces of boiled oil and four ounces of turpentine into the glue pot, and in this dissolve three ounces of resin. When the resin is dissolved, add the glue. The resin and glue should be well stirred while dissolving.

Before applying the leather cover to a pulley have it warm and dry, and scrape off all matter that may have accumulated on its face. Then, with a swab, apply muriatic acid (full strength) to all parts of the face of the pulley. When dry, wipe gently with waste. Cut leather lengthwise of hide, and a little wider than the face of the pulley. Have the cement melted in the glue pot, apply it across the face of the pulley, with a brush, for about six or eight inches, lay on the end of leather and rub it down hard with the corner of a piece of wood. Fold back the leather and continue to apply cement until the pulley is covered. Two thicknesses of leather are used. Make the first thickness a butt joint, and the last a scarf or lap joint of about three or four inches long. Make the laps on the driven pulleys the way they run, and on the drivers the opposite way. Pulleys should be cleaned by holding a piece of coarse sand paper against them. R. F. WILLIAMS.

Montreal, Canada.

HOW TO SAVE UNDERPRINTED OR OVERPRINTED CONTACT COPIES

Blue-prints are never so over-printed that they cannot be reduced to a suitable depth by a slightly alkaline bath of borax, bicarbonate of soda, washing soda, or ammonia. Blackline, or "ink" process paper, is usually lost if slightly over-printed; if under-printed it develops too gray all over its surface to be of use for tracing or for reproduction photographically. In the winter-time, when prints from thick paper drawings are apt to be under-exposed, I treated a number of such apparently useless prints with a lotion for throat troubles—the first "tonic" available—with excellent results, the invisible lines developing out a strong black on a gray ground. The mixture was tannin-and-glycerine solution to about 20 parts of water. When using this solution it is safer to under-print rather than to over-print, with the resulting weak or broken lines.

Sepia prints, when much over-printed, can be saved by washing in a very weak solution of hyposulphite of soda, which bleaches away the image before it can become fixed by the usual preliminary wash in plain water. The hyposulphite solution is so energetic that it will bleach down the darkest of sepia prints if not previously put in water. Purple tones are obtained, after washing, by treating with any gold-toning bath. CHARLES R. KING.

Staple Hill Park, Bristol, England.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

THE LODGE & SHIPLEY "MARVEL" LATHE

A new type of lathe has recently been brought out by the Lodge & Shipley Machine Tool Co., of Cincinnati, O,, which in many respects differs from the ordinary types, and which possesses many valuable features which are entirely original. The prime object in the design of the lathe has been to produce a machine suitable for the rapid production of duplicate parts made from bar stock cut to the required length. One tool in conjunction with a number of automatic stops will turn any number of diameters on any number of pieces to the same dimensions, providing the number of diameters does not exceed the number of stops furnished. The distances between the shoulders on the turned pieces can also be made exactly the same on any number of pieces by using the automatic longitudinal stops provided. As these features are original with the Lodge & Shipley Company, patents have been applied for, covering all of the new devices embodied in this type of lathe.

The machine is built in three sizes, known, respectively, as the 2 by 24, the 2½ by 36, and the 4 by 48-inch, these dimensions referring to the maximum diameters of the stock and the maximum length which can be turned. In Fig. 1 is shown the 4 by 48-inch machine complete, and in Fig. 2 the same machine with the gear guards in the front of the head-stock removed. In Fig. 3 is shown the 2½ by 36-inch size with all parts in place, and in Fig. 4 the same machine with the gear guards at the end of the head-stock removed. In Figs. 2 and 4 the machines are shown in operation, and samples of work are also shown in the same engravings. Figs. 5 to 8 show various details of the machine. Before dealing directly with the operation of the lathe, it will be necessary to give a general description of the design of its various parts.

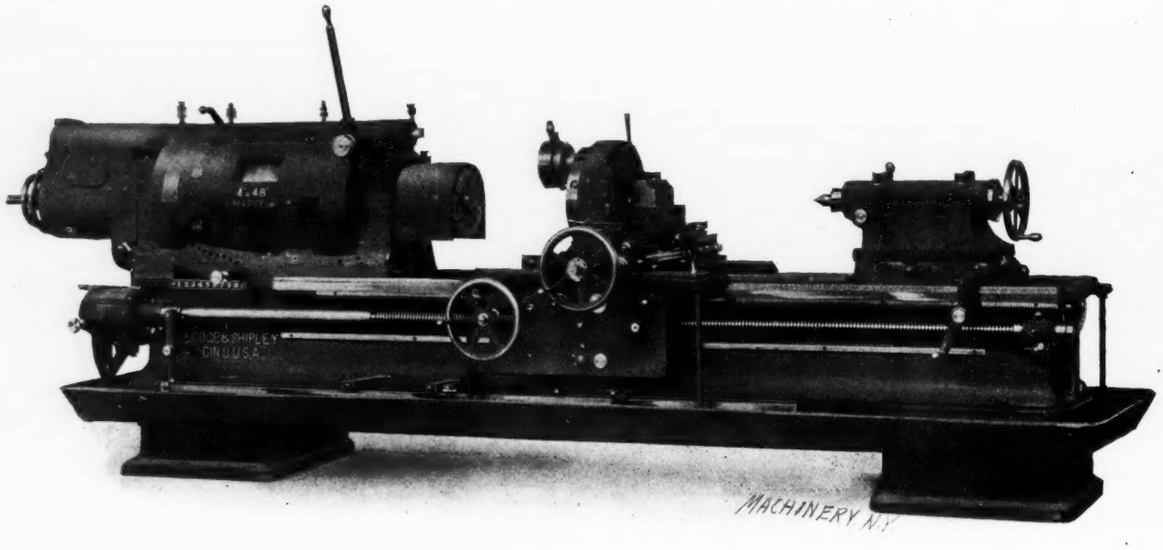


Fig. 1. The Lodge & Shipley 4 by 48-inch Marvel Lathe

The Head-stock and Chuck Mechanism

A side view of the head-stock is shown in Fig. 5; the front end is shown in larger scale in Fig. 6, and a view from the front end in Fig. 7. The head-stock is of the same design as that used in the regular Lodge & Shipley patent-head lathe with double back-gears and single pulley drive, the pulley being carried in bearings independent of the main spindle, thus relieving the spindle and its bearings of all belt pull. The main spindle, which is exceptionally large, is bored out to receive a hollow tube, called the draw tube, the bore of which

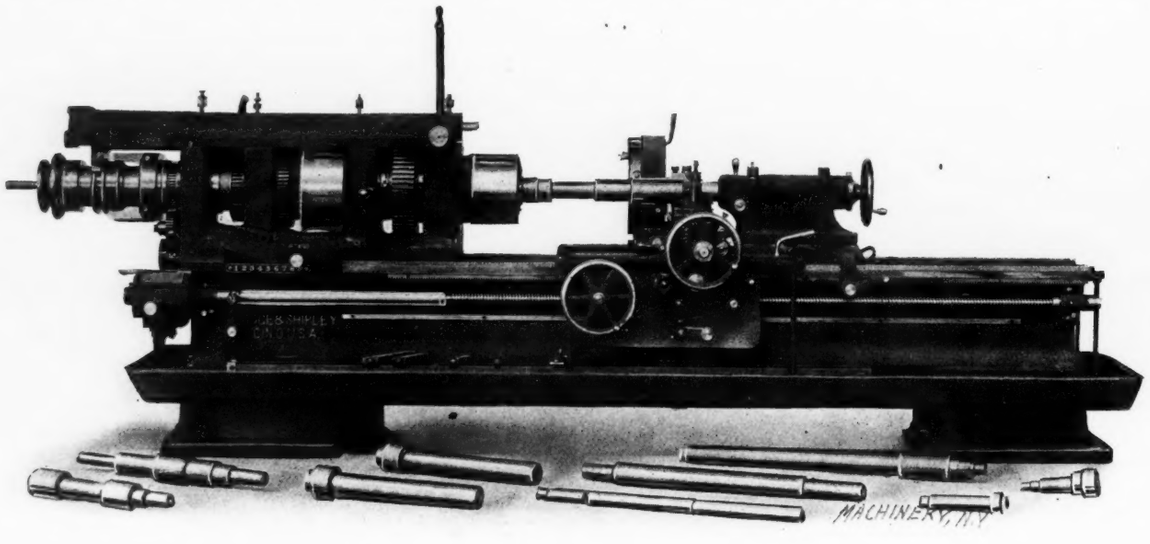


Fig. 2. The 4 by 48-inch Marvel Lathe with Gear Covers Removed, showing Head-stock Arrangement

determines the diameter of the bar stock coming within the capacity of the lathe. The end of this draw tube at the front end of the spindle is threaded, and an adjustable collet fitted to it, the thread furnishing the means for adjusting the collet to any diameter of bar that any one set of jaws will take. The rear end of the spindle projects beyond the end of its bearing, and carries a stepped collar which slides on the spindle. Between the stepped collar and the rear main spindle bearing is another collar backed up by a nut threaded on the

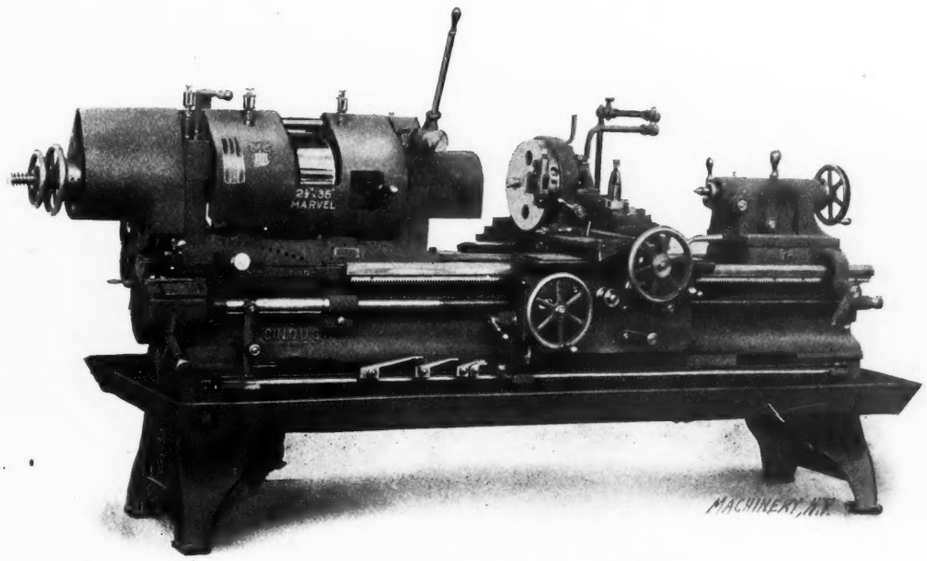


Fig. 3. The Lodge & Shipley 2½ by 36-inch Marvel Lathe

spindle. (See Fig. 5.) In this collar are pivoted two steel levers, the outer ends of which are provided with two hardened steel rollers which rest on the inclined faces of the stepped collar. The inner ends of the levers engage a collar fastened to the rear end of the draw tube, the levers passing through a slot in the spindle. On the extreme rear end of the spindle a threaded collar is placed as a stop for the sliding stepped collar. This threaded collar also serves as an abutment for a compression spring acting against the rear end of the draw tube.

Directly above the main spindle a guide shaft is placed on which slides a yoke engaging the stepped collar. To this yoke is attached a bar which extends immediately over the guide shaft (and over the main spindle gears and pulley) to the front end of the headstock. On the front end of this bar a rack is cut on the under side. This rack engages with a pinion fastened on a shaft at right angles to the main spindle, the end of which projects out on the front side of the machine. On the extreme outer end of this shaft a clutch is placed, the teeth of which engage another clutch which is loose on the shaft and to which is attached a handlever, as shown at the right in Fig. 5. The loose clutch is kept in engagement with the one fastened to the shaft by means of a light spring, which can easily be compressed by hand so as to throw the clutches out of mesh.

The chuck on the front end of the spindle consists of an outer shell or hood threaded on the nose of the spindle. In this hood is secured a hardened conical steel ring. The collet body is carried in a taper bushing in the end of the spindle, the inner end being threaded to receive the draw tube as before mentioned. In the collet body are cut radial T-slots into which are fitted hardened and ground steel jaws, which bear against the conical steel ring in the shell. Springs are inserted in each jaw to keep them in contact with the conical ring.

When operating the chuck, the hand lever before mentioned (shown to the right in Fig. 5) is pulled forward, thereby drawing the stepped collar forward and forcing the lever arms at the rear end of the spindle outward. As the inner ends of the levers bear against the collar at the rear end of the draw tube, this latter is forced backwards together with the collet body, and the radial jaws are caused to slide on the conical ring in the shell, thus gripping the stock. When relieving the grip, the hand lever is reversed, thereby withdrawing the stepped collar from between the lever arms and allowing the spring which acts against the rear end of the draw tube to force it and the collet body forward. The springs in the radial jaws force these out against the conical ring in the shell, thus releasing the stock.

A coarse pitch screw acting as a stock stop passes through the center of the draw tube and is supported at the front end by a collar which is a sliding fit in the bore of the draw tube, and on the rear end by a nut secured to the extreme rear end of the main spindle. Mounted on the screw immediately behind the nut are two hand-wheels, the inner one of which is keyed onto the screw by a key movable longitudinally in a spline, and the outer one threaded and operating as a lock-

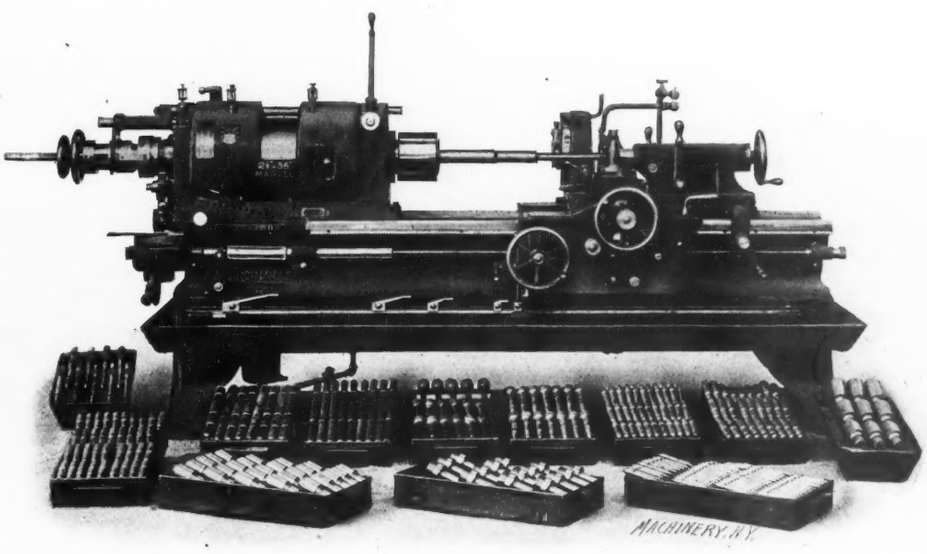


Fig. 4. The 2½ by 36-inch Marvel Lathe with Covers Removed showing Chuck-operating Mechanism

nut. When the inner hand-wheel is revolved, the screw revolves with it, and is caused to travel through the nut secured to the main spindle, thus giving end adjustment. The screw can be locked in any desired position by the outer hand-wheel. The front end of the screw is arranged to receive either a small center or straight stop bar.

Carriage and Tool-posts

The arms of the carriage bear on two outer V's of the bed. The bridge also has a bearing on the top and inside

of the flat track of the front shear. The bridge of the carriage is exceptionally wide and, as will be seen from Figs. 7 and 8, is extended beyond the back of the carriage. Two independent transverse dove-tails are planed on the bridge, the one on the right-hand side (looking at the machine from the front) being raised considerably above the other and extended the entire length of the bridge and its rear extension. The other dove-tail extends from the rear of the bridge extension a little past the lathe center. The right-hand dove-tail is fitted with a slide which carries the front and back tool-blocks. The front tool-block consists of a

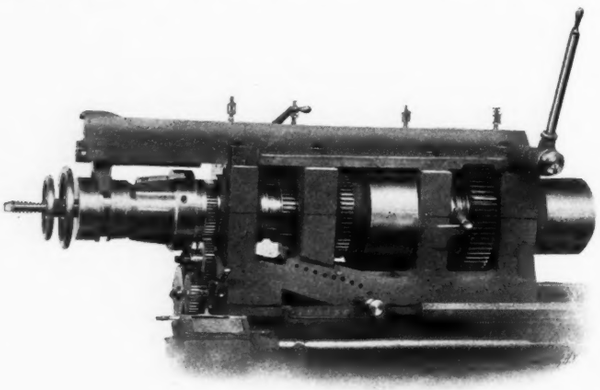


Fig. 5. The Head-stock of the 4 by 48-inch Marvel Lathe with Covers Removed showing Details of Head Construction

slide fitted in a dove-tail parallel with the main spindle, for the purpose of providing a longitudinal screw adjustment for the front tool; when adjusted, this tool-block is locked in position by a clamp screw. A large longitudinal T-slot at the top receives the usual form of tool-post and step washer. The rear tool-block has transverse hand adjustment and is clamped by two T-bolts in a T-slot planed in the main slide. This block also has a large transverse T-slot for receiving either the usual form of tool-post or a tool-holder of the European type, shown in place in Figs. 6, 7 and 8. Due to the separate adjustment, the tools in the front and rear tool-blocks can be set in any required relation to each other and can be rapidly, independently and accurately adjusted.

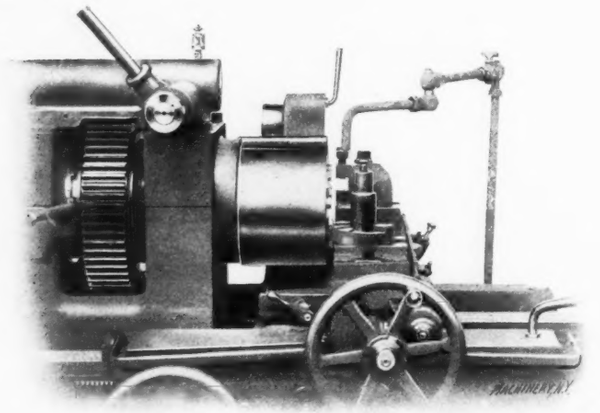


Fig. 6. Front End of Head-stock of 4 by 48-inch Marvel Lathe, showing Chuck, and Lever for operating Chuck Mechanism

In the left-hand dove-tail of the carriage is fitted a slide which carries a rotating tool-holder, a kind of vertical turret. In the face of this tool-holder which is turned toward the head-stock are reamed four holes to fit various tool shanks. (See Fig. 8.) The holes are so placed that when the tool-holder slide is locked to the carriage by means of a spring plunger provided for the purpose, each one of the tools in the face of the revolving tool-holder can be brought into a position so that its center coincides with the axis of the main spindle. The revolving tool-holder is locked to its slide in each position by a spring plunger. Tools of various types, such as centering tools, die holders, etc., may be placed in the holes in the revolving tool-holder, and necking tools, cutting-off tools, and turning tools may be carried in holders bolted to the face of the revolving tool-holder, so that their cutting edges project beyond the edge of the tool-holder itself. These tools, then, can be used for turning operations. An adjustable stop is provided in the carriage for use in connection with turning and necking tools, so that they may repeatedly be brought into exactly the same position relative to the main spindle center, thus insuring exact duplication of work without measuring each piece. A single lever operates this stop and also the spring plunger, which locks the revolving tool-holder slide to the carriage. A similar lever also operates the plunger which locks the revolving tool-holder to its slide. Both these levers are shown in Fig. 8, one at the end of the slide, and the other on the side of the projecting housing. The right-hand slide carrying the front and back turning tool and the slide carrying the revolving tool-holder are traversed back and forth by the same hand-wheel at the front of the carriage; but, at the same time, the movement of each of these slides is entirely independent. This is accomplished by means of a friction or slip member inserted in this hand-wheel.

Automatic Stops

One of the most important and noteworthy features in the design of the carriage is the automatic stop used in connection with the front and rear tools carried on the right-hand slide, by which a number of different diameters can be rapidly and accurately turned on a number of duplicate parts. The construction of this stop is as follows: Along the side of the bridge of the carriage next to the tail-stock, and journaled in two hubs cast on the front and rear arms of the carriage, as shown in Fig. 7, is a heavy bar with T-slots milled lengthwise through that part of the bar which is between the arms of the carriage. The bar is reduced at one end for a certain distance to a diameter just below the bottom of the T-slots, so as not to interfere with the insertion of the T-bolts into the slots. The bolts secure small steel stops in any desired position on the slotted bar, as clearly shown in Fig. 7. On the front end of the bar means are provided for taking up end wear, so that a snug running fit may always be maintained. On the outside of the rear bearing is secured a steel clutch, the teeth of which correspond to the T-slots in the bar. Engaging with this is another clutch keyed to the rear end of the slotted bar, and kept in engagement with the stationary clutch by means of a spring. On the outside of the clutch on the bar are cut spiral grooves corresponding in number to the number of slots in the slotted bar. On the edge of the tool-block slide next to the tail-stock are two hubs, the front one being cast solid with the slide, while the rear one is adjustable longitudinally by means of a T-slot and T-bolt. In each of these hubs a shaft is journaled parallel with the slotted bar; to the inner ends of the shafts steel fingers are secured. In the ends of these fingers and also parallel with the slotted bar, two screws are threaded and provided with means for locking them in

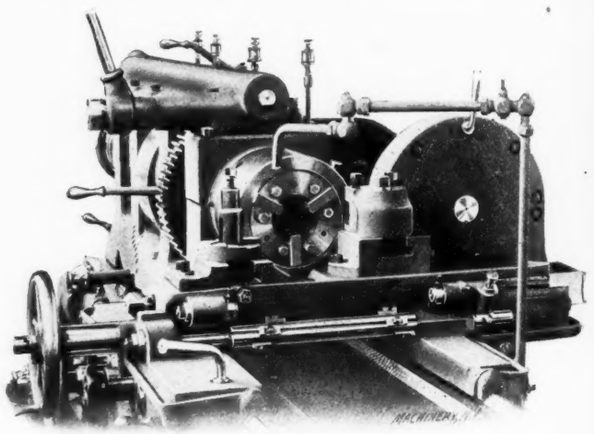


Fig. 7. Front View of Head-stock and Side View of Carriage of 4 by 48-inch Marvel Lathe showing Automatically-revolving Stop Bar

position when adjusted. The fingers each have two positions, one for engaging the stops on the slotted bar and the other for allowing the fingers to pass over the stops. These positions are both maintained by means of a spring latch.

The slotted bar has two sets of stops as shown. One set engages the screw in the steel finger on the front end of the slide and is used in connection with the front tool. The other engages with the steel finger carried by the adjustable block on the rear end of the slide and is used in connection with the rear tool. In the rear hub there is also a spring pin, the end of which engages with the spiral grooves cut on the outside of the clutch keyed on the end of the slotted bar. These grooves are so formed that the forward movement of the slide will cause the end of the spring pin engaging the spiral groove to compress the spring which keeps the clutches in engagement. This action continues until the clutch teeth are disengaged, at which time the slotted bar will revolve by the continued movement of the slide, the end of the spring pin traveling in one of the spiral grooves. The length of the spiral grooves is so determined

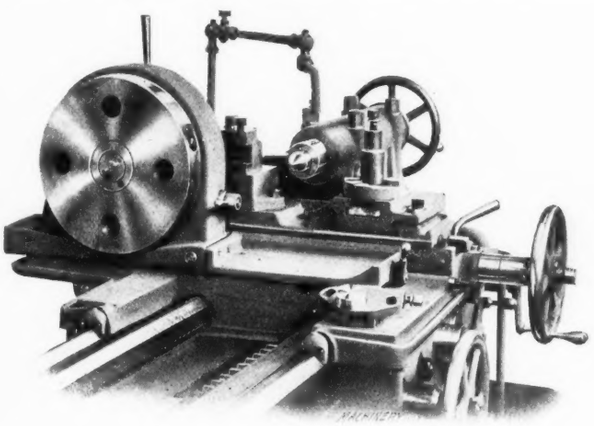


Fig. 8. Side View of Carriage of 4- by 48-inch Marvel Lathe, looking toward Tail-stock, showing the Rotating Tool-holder

that when the slotted bar has revolved sufficiently to bring the next set of stops into position, the end of the spring pin passes out of the groove and at this time the clutch teeth come into engagement, the clutch being actuated by the spring previously compressed. The movement of the slide is then continued until a stop is reached. On the return movement of the slide the end of the spring pin will again enter the same groove, but instead of any movement being imparted to the clutch, the groove is so formed that the spring pin will ride over the top of the spiral and drop into position in the next groove in the clutch. It is obvious that by means of this automatic stop arrangement a number of various diameters, not, however, exceeding the number of stops on the slotted stop bar, can be rapidly turned on a number of similar parts.

The longitudinal stops provided on this lathe are of the same type as those described in connection with the Lodge & Shipley crank-shaft lathe in the June, 1909, issue of MACHINERY and will be but briefly referred to here. Along the front of the bed just below the apron is placed a rectangular bar, which slides in brackets bolted to the bed. The top of the bar is planed in the shape of a dove-tail, and telescoping stops adjustable the entire length of the bar are screwed to it by means of clamp bolts. The head end bracket, holding the bar, carries a spring and solid abutment which limits the sliding movement of the stop bar. The lead-screw is divided at the front of the head-end box, thus making two separate parts; on the right-hand end of the short piece in the box is formed a clutch, which engages with a sliding clutch keyed to the end of the lead-screw. This clutch is connected to the stop bar along the front of the bed by means of a lever pivoted to a stud as shown in Figs. 1 to 4. When actuated the bar has just sufficient movement to disengage the clutch.

At the bottom of the apron, as shown in Figs. 1 to 4, is bolted a bracket with a pivoted arm which engages the stops on the sliding bar. When engagement takes place, the bar slides with the carriage until the clutch on the lead-screw is drawn out of mesh, thus stopping the feed. At the same time the bar comes against its solid abutment at the head end of the bracket. The pivoted arm may be raised out of engagement with the stop, at which time the spring previously compressed by the movement of the bar will force the bar back to its former position and re-engage the clutch, thereby again starting the feed.

The previous description of the main features of the machine will make a concise description of the operations performed on the machine possible.

Operation of the Marvel Lathe

The stock to be operated on is delivered to the operator of the machine cut in pieces to the required length. The advantages of this procedure over that of using the stock in a bar passed through the spindle are marked. A considerable amount of floor space is saved, and no stock projects beyond the back end of the machine. The stock is more easily handled, and when the machine is in operation there is no vibration and no noise from a long bar, seldom quite straight, revolving in loose supports. The vibration caused by parts revolving in this manner also greatly impairs the accuracy of the work and the smoothness of the finish.

In the Marvel lathe the piece to be operated upon is inserted in the front end of the chuck and is gripped so that sufficient stock is left for the operation to be performed. The gage screw inside the draw tube is brought against the stock and is then locked. Now the revolving tool-holder carrying a centering tool is brought into position and the projecting end of the piece is centered. The revolving tool-holder is then returned to its rear position, and the tail center is inserted into the center just made in the work and is then clamped in place. The first cut is now started with the tool in the front tool-post and the first stop on the diameter stop bar at the rear of the carriage is clamped in position to give the diameter required. The cut is then allowed to travel the required distance, and the shoulder stops in the front of the machine are set in position. The tool is then withdrawn and the back tool is used for squaring the shoulder, its stop being properly set. The forward movement of the slide for the next cut revolves the diameter stop bar and brings the second stop into position, and the second diameter and shoulder are then turned in the same manner as the first. When the turning of the piece is completed, it is removed from the chuck, but if the piece is of such a nature as to require an operation on the end gripped by the chuck, the finished end is inserted into the chuck and the rough end permitted to project sufficiently to complete the work to be done. When the piece is gripped in the chuck, the projecting end is centered in the same manner as before and the tail-stock center inserted, the following operations being the same as already described.

It is evident that in this manner any number of pieces can be turned rapidly and accurately to the same dimensions. On one of these machines in the Lodge & Shipley shops, any twenty-five pieces taken from a lot have been found not to vary over 0.002 inch either in diameter or length between shoulders. The method of holding the work insures the greatest possible accuracy, in addition to which some operations impossible on the ordinary turret lathes and screw machines are easily performed.

BESLY DOUBLE SPIRAL DISK GRINDER

The accompanying half-tone illustrates a new grinder brought out by Charles H. Besly & Co., 15-21 So. Clinton St., Chicago, Ill., and manufactured at the company's works at Beloit, Wis. The machine is known as the No. 26 Besly double spiral disk grinder and embodies the same general features as to construction, power, rigidity and accuracy, which have previously been referred to in these columns in descriptions of the Besly grinders.

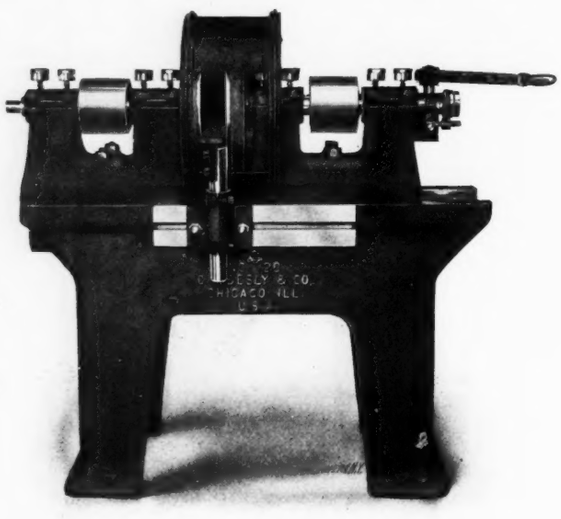
The bed and legs of the machine are cast in one piece, and the bed is provided with a T-slot pad in the front, as shown. The work-rest carriage is attached to the machine by means of two bolts fitting into the T-slot. Seven work-rests are fur-

nished with each machine, varying in width from 7/16 inch up to and including 2 7/16 inches. The heads of the machine are carefully fitted to the top of the bed casting, and are bored and reamed to receive bearing bushings. These bushings are made in halves with the exception of the long rack or lever bearing at the right-hand end of the machine, which is 10½ inches long and made in one piece. The end thrust is taken up by hardened and ground steel collars of large area, and ample provision is made for taking up all wear. Over the bushings are fitted removable caps into which the oil cups are screwed; particular attention has been given to the lubrication of all the parts of the machine.

A dust hood of special construction encloses the disk wheels. This dust hood is built on the telescoping plan, so that the opening between the edges of the dust hood are never greater than the width of the pieces being ground. The top of the hood is hinged and can be thrown back instantly to give free access to the wheels. An opening is provided below the wheels for attaching a 5-inch exhaust pipe.

An interesting feature in the design of this machine, to which attention should be called, is the provision made for a third wheel and rocker shaft, which can be attached to the left-hand end of the machine at any time. On this shaft can be mounted either the geared lever feed table or the swinging or tilted tables made by the company.

The operating floor space required for the machine is 5 by 10 feet, the floor space of the machine itself being 20 by 44

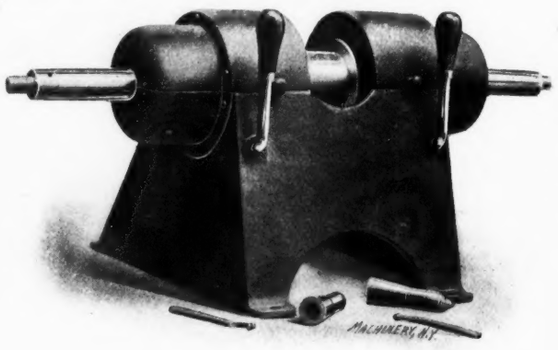


No. 26 Besly Double Spiral Disk Grinder

inches. The height from the floor to the center of the spindle is 42 inches. The disk wheels used are 18 inches in diameter and ⅝ inch thick and run at a speed of 1,650 revolutions per minute. The maximum opening between the disks is 10½ inches. The spindle pulley is 6 inches diameter with 5¼-inch face. The counter-shaft should run at 618 revolutions per minute in order to drive the disks at 1,650 revolutions. The driving pulley and drum pulley are 16 inches in diameter for 5-inch belt, and the tight and loose pulleys 10 inches in diameter for an 8-inch belt. The weight of the machine complete with counter-shaft, not crated, is 2,100 pounds.

DUPLEX INDEPENDENT END BUFFING LATHE

One of the inconveniences of the ordinary double end buffing lathe used by jewelers, silversmiths and others for polishing, is that it is necessary to stop work on both wheels when one wheel is changed, due to the fact that both polishing wheels are fastened to the main shaft. As the wheels have to be changed frequently, and as it requires some time to change a wheel, the loss of time is considerable. To overcome this difficulty, single end lathes are sometimes used, but the comparative unsteadiness with which they run makes it impossible for an operator to perform good work, and the extra amount of space required for an equal number of operators is considerable. For this reason, A. B. Nutting & Co., Amesbury, Mass., have brought out a new double polishing lathe where the polishing wheels can be independently thrown into or out of engagement with each other by means of simple friction clutches, operated by the hand levers in the front of the machine shown in the accompanying illustration. A slight movement instantly throws one wheel into or out of action without shifting the belt or interfering with the running of the other wheel.

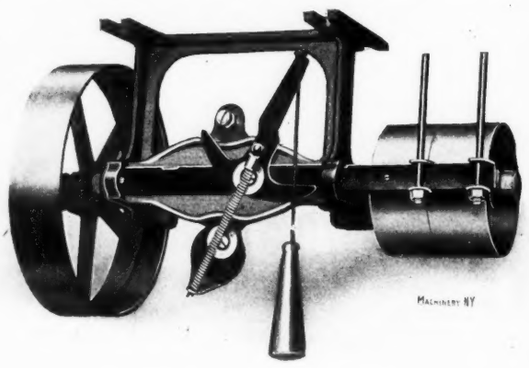


Nutting Duplex Independent End Buffing Lathe

The frame of the machine which occupies a bench space of 12 by 17 inches is made in box form and is provided with dust-proof casings covering the bearings and working parts completely. The bearings are cast to the frame so that they are always in alignment and the journals are constantly flooded with oil. The spindles and the main shaft have a special adjustment to compensate for the end thrust wear. The ends of the spindles are detachable and any length or form can be substituted, making it possible to use the machine for all classes of work. The drive is by means of a 3 by 3-inch pulley running between the bearings as shown and belted from above or below. All the running parts are balanced and can be run at a rate of 3,500 revolutions per minute without causing difficulties.

PULLET BELT SHIFTER AND COUNTER-SHAFT

A decided improvement on the old wood shipper for shifting the belts on counter-shafts is shown in the accompanying half-tone, illustrating the Pullet belt shifter and counter-shaft brought out by the L. & D. Co., 88 Broad St., Boston, Mass. The construction of this shifting device is as follows: An oscillating lever to which a pull cord is attached is mounted on a sliding shifter bar and is kept in position by a compression spring which also locks the shifter bar at each

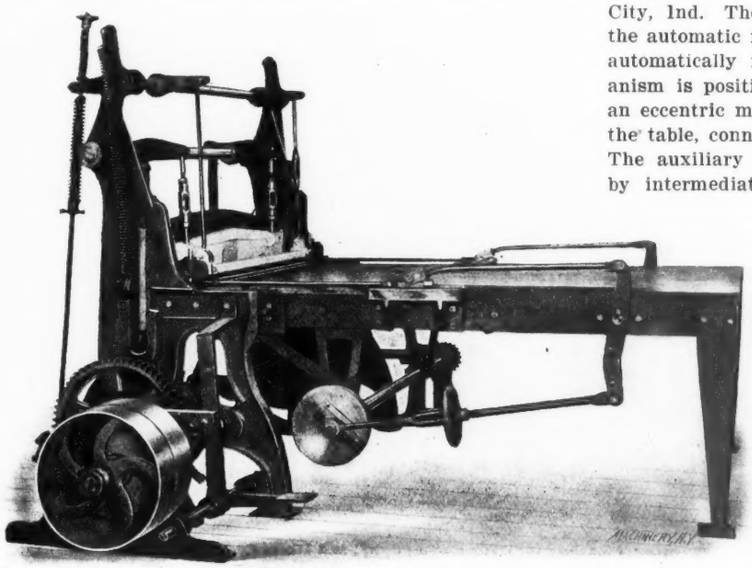


The Pullet Belt Shifter and Counter-shaft

stroke. The pivoted spring support always keeps in line with the direction of the push of the spring. When the handle attached to the cord is pulled, one wing of the oscillating lever engages a pin fixed in the base-plate. This pin then acts as a fulcrum so that the shipper bar is forced to the left (assuming the parts to be in the position shown in the illustration). The initial pull on the pull cord forces down the shipper bar so that the notch in it no longer engages the frame casting, thereby permitting the bar to move.

At the end of a stroke, however, the notch at the other end engages a stop on the base-plate, and as the center of rotation of the oscillating lever is now on the opposite side of the vertical center line, the spring throws it into a position the reverse of that shown in the illustration, from which it is ready to be shifted back by a new pull on the cord. Thus a pull on the cord will shift the belt in either direction.

One advantage of this shifter is that the handle can be located directly over the work. By clamping the base-plate upside down and running the cord over pulleys, the machine can be stopped and started from any point. The shifter can be applied to any ordinary counter-shaft by clamping it to a



Automatic Feed Shear built by Bertsch & Co.

pipe screwed into a flange in the ceiling, thus making it adjustable vertically. In the illustration, however, the special Pullet counter-shaft is shown, provided with a frame to which the shifting device is directly attached. While the hanger and shifter support are complete in one casting, the shifting device can be quickly inverted, so that a pull cord can be run over pulleys as already mentioned.

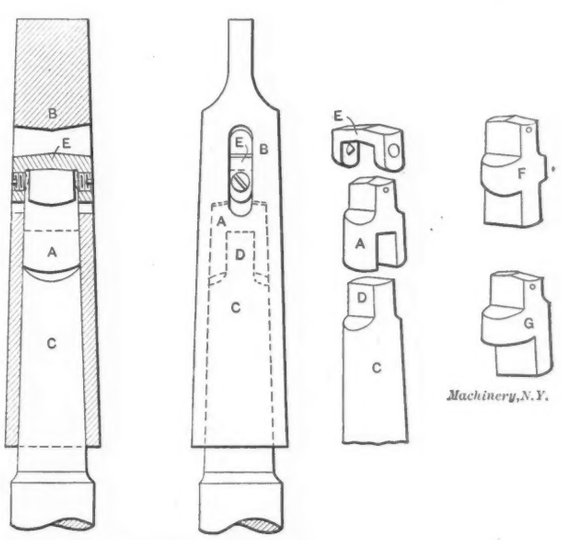
There are three sizes of the Pullet shifters, each size being adjustable for two lengths of throw (two widths of belt). For instance, a shifter for 1½ and 2-inch belt, respectively, can be used for the one or the other, simply by turning over the shifter bar so that the respective notches are brought into use. The shifters have the further advantage that they cannot easily get out of order. They make the shop look neater and more pleasant than when full of wooden shippers, and the simplicity of construction brings the cost to a very reasonable figure.

GROSS & GROSS INTERMEDIATE DRILL SHANK TANG

The device shown in the accompanying line engraving is an improved method of driving twist drills and other tools provided with an end tang for driving, and is the invention of Messrs. Gross & Gross, 1616 No. 4th St., Harrisburg, Pa. In order to overcome the common occurrence of the tangs of twist drills becoming distorted or broken off on account of being subjected to too great a stress, an intermediate driving block *A* has been provided which may be placed in the socket *B*, and it is only necessary to form a new tang on the drill shank *C*, after the original tang has been broken off. Any torsional stress on the drill shank and tang will be transmitted to this intermediate tang, which will break before the new tang *D* on the drill shank *C*. If the intermediate tang *A* breaks, a new one can readily be substituted for the broken one at a cost which is comparatively slight as compared with the cost of a new drill. In operations where a frequent change of drills is not required, the intermediate tang is used without the part *E*, but in operations where it is required to change the drill often, the intermediate tang is used in connection with a holder *E* to prevent the falling out of the intermediate tang from the socket at the time of removal of the drill; this holder may also be conveniently manipulated to disengage the drill in the socket. The intermediate tang *A* may be used for any make of socket; at *F* and *G* are shown modified forms of the intermediate tang.

BERTSCH AUTOMATIC FEED SHEAR

In the accompanying illustration is shown a new shear recently designed and built by Bertsch & Co., of Cambridge City, Ind. The most prominent feature of this machine is the automatic feed mechanism whereby the sheet to be cut is automatically fed in between the blades. This feed mechanism is positive and works very accurately. It consists of an eccentric mounted on an auxiliary shaft suspended under the table, connecting rods and levers, and a clamping device. The auxiliary shaft is driven from the main driving shaft by intermediate gearing. The clamping device consists of two plates or jaws which at the proper time grip the sheet and automatically move it towards the blades. At the moment when the feeding mechanism has placed the sheet in the required position to be sheared, the regular "hold-down" descends ahead of the top knife and holds the sheet in place during the shearing operation. While the shearing is being done, the plates or jaws of the feeding mechanism release the grip, and move away from the blades into a position where they are ready to grip and feed the sheet for the next cut. The jaws gripping the sheet are opened and closed by means of an eccentric on the main driving shaft, which actuates the connecting arms and rods shown in the illustration above the clamping device. The feeding mechanism can be so adjusted that it will automatically shear the sheet into uniform strips of any width from 1/16 inch to 12 inches. Either a single sheet of any desired width up to the capacity of the machine, or several narrower sheets placed side by



A New Device for making possible the Use of Broken-off and Re-tanged Twist Drill Shanks in Regular Drill Sockets

side can be automatically fed in this manner. Owing to the fact that the feed mechanism is designed as an independent device attached to the machine, it can be applied to any standard shears built by the makers.

An automatic feed arrangement of the type shown adds considerable to the usefulness of the shear, and makes possible a marked increase in the output, at the same time as accuracy of the product is much more easily obtained.

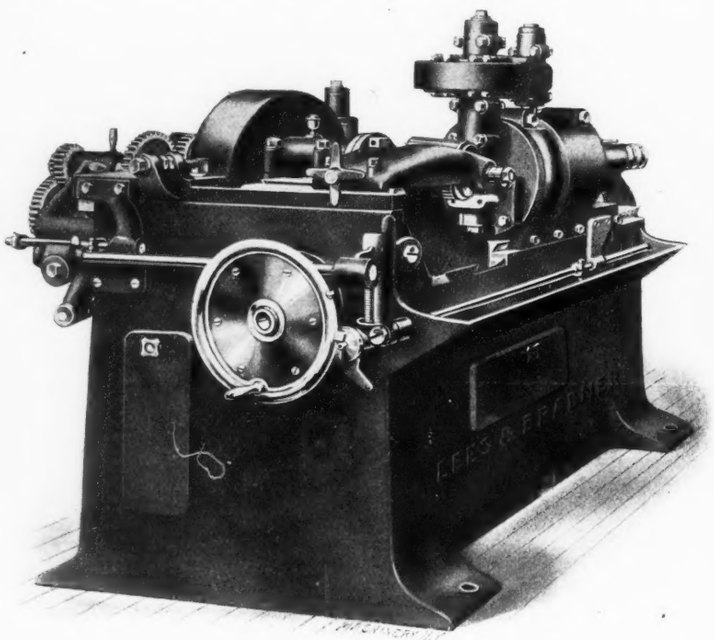
LEES-BRADNER AUTOMATIC GEAR-CUTTING MACHINE

The accompanying illustration shows a general view of a machine designed by Mr. E. J. Lees of the Lees-Bradner Co., 923 Schofield Building, Cleveland, O., and intended for hobbing spur, spiral and worm gears and also for threading worms. The machine has a capacity of cutting spur and spiral gears of up to 14 inches in diameter and four diametral pitch; worm gears of the same diameter up to one inch circular pitch; and worms of one inch pitch and any lead, up to 8 inches long and 8 inches in diameter. The machine works on the generating principle, using hobs for cutting gears. For worms, however, a single cutter is used, the machine working in a manner similar to a thread milling machine.

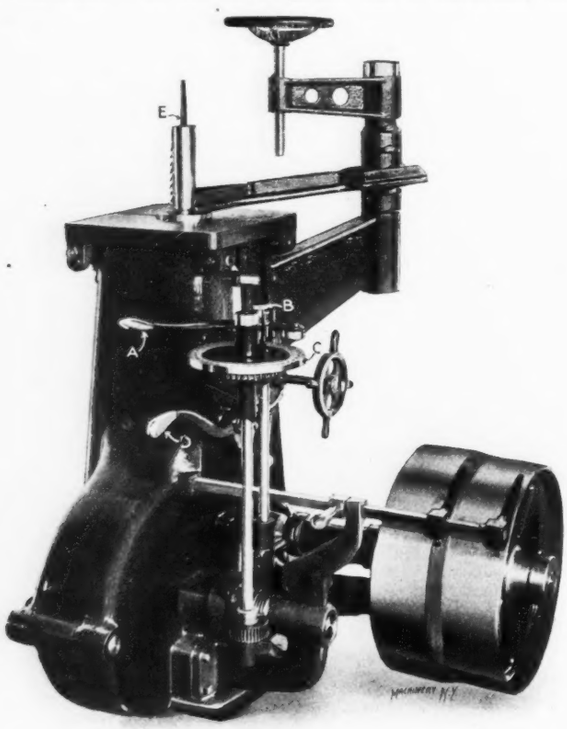
The drive of the machine is by belt on a three-step cone, and the machine is back-geared in the ratio of 8 to 1. The swiveling head can be moved 180 degrees and has no over-hang. The swiveling mechanism consists of one pair of bevel gears inside of a large cylindrical head, which in turn fits into another cylindrical bearing on a slide. The mechanism is rigidly locked to the slide by bolts on either end. All movements are in one direction in all operations, so that backlash is entirely eliminated. The screws used for feed and head slides operate with a draw pull and not with a pushing action.

The work-spindle and arbor are horizontal, and the arbor is rigidly supported at both ends, which is highly important, especially when cutting the teeth in spiral gears. Provision has been made in the design so that the larger the diameter of the gear to be cut, the closer the cutter is brought to the original point where the power to the cutter spindle is delivered. As the work-spindle has a three-inch bore, gears made in one piece with, or placed on, a shaft can be either held in the spindle with a draw-in collet or can be held between centers.

A micrometer is provided for gaging the depth of the cut with graduations on a disk 6 inches in diameter, which is locked at zero with a thumb-screw when starting to take the reading. This provides for an easily adjusted and quickly operated micrometer for duplicate work. When operating the machine the necessary depth is obtained by adjusting the head at the same time the micrometer is set, after which the work is fed across the cutter head. At the completion of a cut the main drive is automatically thrown out and all mechanisms stopped simultaneously. This is a necessary requirement in cutting spiral gears and relieves the operator of constantly watching the machine in order to stop it at the right moment. When setting for the depth of cut, a stop rod collar is adjusted, and an original feature introduced permits the slide to be backed away to any distance and yet returned to its original setting to a positive stop without attention to graduations; although, if the operator wishes to set the cutter in or out a few thousandths inch, the original reading is visible on the disk and can be worked from.



Lees-Bradner Machine for Cutting Spur, Spiral and Worm Gears and for Threading Worms



Lapointe Vertical Key-seating Machine with Automatic Feed, Release of Cutter and Stop

A feature of interest in the machine is that it can cut worms advantageously. When cutting or threading worms a single cutter is used running from 75 to 117 revolutions per minute. The cutter head is very rigid in order to eliminate any possibility of lack of uniformity in the worm thread. The worm can be mounted on an arbor held either between centers or in a draw-in collet, the other end of the arbor being supported either on a center or in a bushing.

All the mechanism is in one horizontal plane, and, therefore, all parts can be readily reached. Adjustments are provided where required for taking up back lash. The chips are disposed of without coming in contact with any of the moving parts and are removed by taking out a pan located directly back of the door in the frame of the machine. The chip pan and the receptacle for oil are the only parts inside of the frame. The oil pump is located on the outside and below the oil supply, which obviates the necessity of priming the pump.

LAPOINTE VERTICAL KEY-SEATING MACHINE

The machine illustrated in the accompanying half-tone engraving is designed and built by the Lapointe Machine Tool Co., Hudson, Mass. It is intended for general key-seating, and is provided with automatic feed, automatic release for the cutter, and automatic stop for any depth of keyway desired. The work to be operated upon in the machine is first put onto a bushing fitting the hole in the work, and is fastened by means of a clamping arm, one end of which rests on the work and the opposite end on a post adjustable to the height of the work; the clamping arm is held down by

means of a screw provided with a hand-wheel. The machine is then started by means of the operating handle *A* and the depth of cut required is determined by means of the depth regulator *B*, which can be set in any of the holes in the index plate *C*. When the machine is in operation, the index plate revolves, and in due time the depth regulator or finger comes in contact with a cam on the operating lever, thereby stopping the machine. The index plate is provided with forty holes, the distance between each hole being equivalent to a depth of 0.010 inch in the keyway.

The cutter consists of a broaching bar provided with ten teeth, each cutting its proportionate part at each stroke of the bar. The fact that the bar is provided with a series of teeth reduces the number of strokes necessary for cutting keyways as compared with the time required when using a bar with a single cutter. The feeding of the cutter is accomplished by means of a wedge *E* sliding on the back of the bar, automatically advancing at every stroke, and automatically released on every return stroke by allowing the wedge to drop back half the distance of its advance, so that the cutter is prevented from rubbing against the work on the return stroke. The machine is provided with quick return for the cutter bar.

The machine has a tilted table used when cutting tapered keyways, and is also arranged for hand operation when required, the feed being disconnected by the feed-key releasing handle *D*. The drive is by means of a tight and loose pulley, so that it can be belted directly to the main shaft, thereby making a countershaft unnecessary. The loose pulley is provided with a self-oiling arrangement and will run for at least a year without attention.

THE CHICAGO DUPLEX HAND MILLING MACHINE

A number of improvements have been introduced in the new design of the Chicago hand millers, manufactured by the Chicago Machine Tool Co., of Chicago, Ill., the most important ones of which are illustrated in the accompanying half-tone engravings. The machine is of the "Duplex" type, the name being derived from the fact that a vertical attachment is furnished with each machine. The combination of both vertical and horizontal spindles on the same machine, together with an exceptionally large range for a hand miller, adapts it to a large variety of work. The machine illustrated is known as the No. 3 Duplex miller, and is shown in Fig. 1 with the vertical attachment in place. This attachment is one of the most important features of the machine, as it makes it particularly adapted to tool-room work and also makes it valuable in the manufacture of small parts for locks, typewriters, guns, sewing machines, etc. In Fig. 5 is shown a front view of the machine with the vertical attachment in place. It will be noted from these two illustrations that the machine is of a particularly rigid design. The table has a very wide bearing on the saddle in order to insure rigidity, which is an essential feature in any type of milling machine. A taper gib is provided for taking up the wear; this gib is easily adjusted when required.

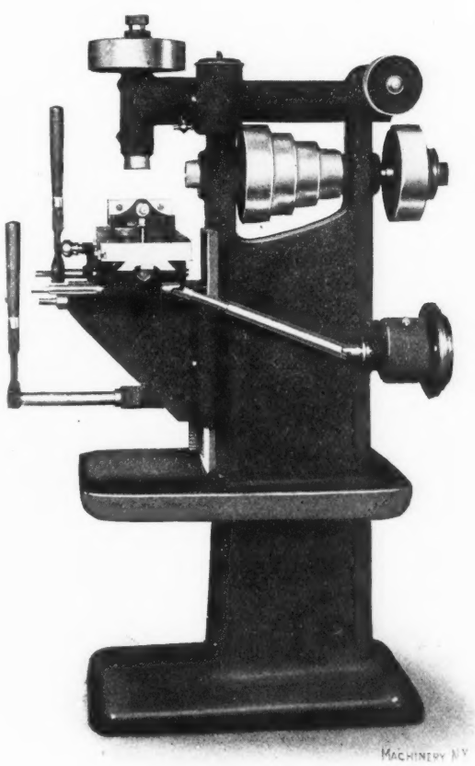


Fig. 1. Chicago Machine Tool Co.'s No. 3 Duplex Hand Milling Machine with Vertical Attachment

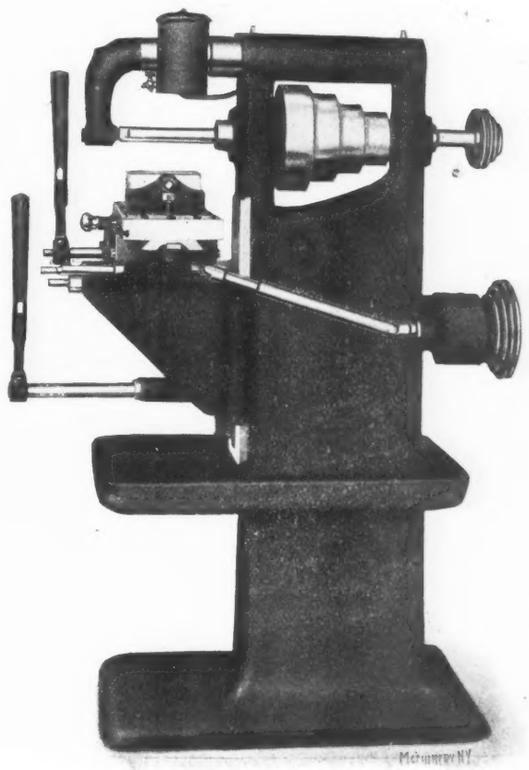


Fig. 2. The Chicago Duplex Miller with Overhanging Arm, ready for Horizontal Milling

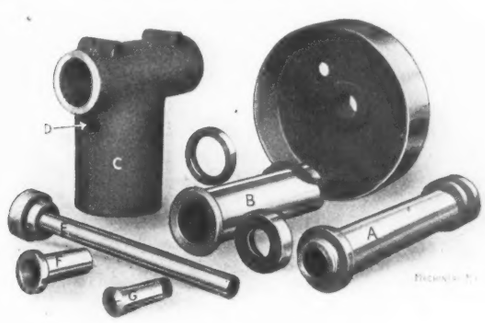


Fig. 3. Parts of Vertical Milling Attachment

The saddle is so proportioned that the overhang of the table is minimized even when feeding the work to the limit of the capacity of the machine. The design permits the application of automatic feed at any time, if required. The knee is of box construction, and having no opening at the top, there is no tendency to spring it when the saddle is clamped. It will be noted in Fig. 1 that the knee has a long bearing on the column in order to give the required stiffness. The machine has a crank feed for the table as well as a hand lever

feed and power feed. The hand lever can be used to good advantage for quick return of the table after a cut has been taken. A hand lever feed for the vertical movement of the knee is also provided, as shown in Fig. 5. This hand lever is fastened to a shaft carrying on its other end a pinion meshing with a rack secured to the column. A bracket which carries the nut for the transverse feed-screw is fastened to the saddle and extends into a slot cast in the side of the knee. This arrangement protects the feed-screw and prevents chips or dirt from falling inside the knee.

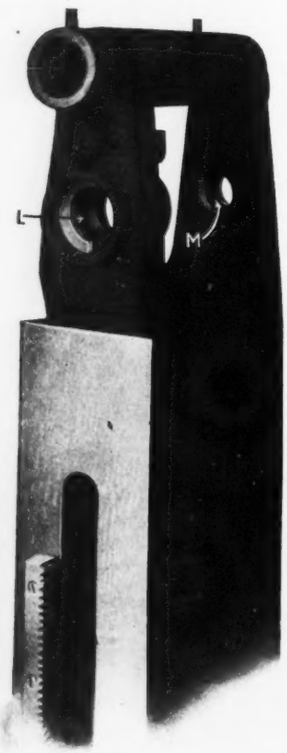


Fig. 4. Part of Column for Hand Miller, showing Oil Reservoirs

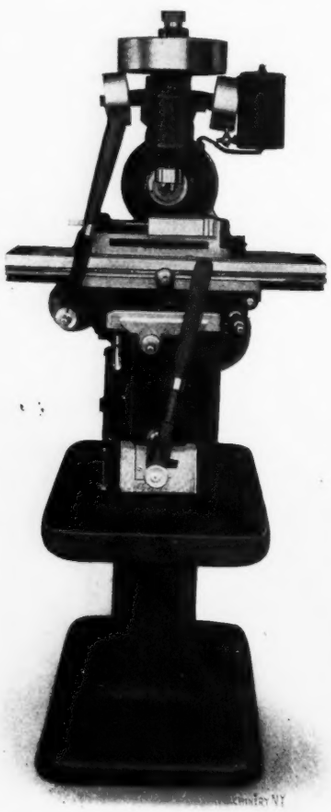


Fig. 5. Front View of Chicago Hand Miller with Vertical Attachment

The Vertical Attachment

One of the main features of the vertical attachment is that there are no gears in connection with its drive, it being driven by a belt from a pulley on the rear end of the horizontal spindle, as shown in Fig. 1. The belt runs over idler pulleys shown at the top of the machine. In Fig. 3 are shown the main parts of the vertical attachment. The spindle *A* is bored to receive a No. 9 Brown & Sharpe taper. This spindle runs in the split bronze bearing *B*, a slot in which runs the entire length of the bearing and in which is laid a wick for lubrication. The casing *C* which contains the spindle bearing, spindle and other parts, is also split and provided with screws for taking up any wear that may occur in the bearing. In this casing an oil reservoir *D* is provided, this being cored out in the casting. The ends of the wick previously mentioned are dipped into this reservoir which contains enough oil for the running of the machine for a full year. The arrangement insures perfect lubrication of the bearings, eliminates wear, and makes smooth running possible. The same illustration also shows the draw bar *E*, the sleeve *F* and the collet *G*. End mills are held in place in the vertical attachment by the draw-in collet, this latter being interchangeable on the vertical and horizontal spindles.

Fig. 6. Horizontal Spindle and Bearing Bushings

The Machine Used as a Horizontal Miller

In Fig. 2 the machine is shown with the vertical attachment removed and the overhanging arm in place supporting the outer end of the arbor. It takes but a few minutes to change over the machine from vertical to horizontal. The horizontal spindle of the machine is bored to receive a No. 9 Brown & Sharpe taper shank.

The respective parts of the horizontal spindle are shown in Fig. 6, in which illustration *H* is the spindle proper, and *J* and *K* bronze bearings fitted to tapered bores in the column. Adjusting collars are provided for taking up the wear occurring in the bearings. The wicks provided for the lubrication are also shown and a good idea of the novel arrangement provided for the oiling of the bearings may be obtained from Fig. 4. Two reservoirs *L* and *M*, cored out in the casting, are provided in the column under each bearing; these are filled with cotton and oil and furnish sufficient lubrication for a full year by means of the wicks in the bronze bearings laid in a groove cut for the purpose. The machine may thus be run at high speeds without danger of heating the bearings.

The Power Feed

The power feed of the machine is taken from a cone pulley at the rear end of the spindle to a three-step cone pulley on the rear of the gear box, as shown in Fig. 1. From the gear box the drive is through the universal joint shaft to a pair of 45-degree spiral gears in the saddle. As shown in Fig. 7, a worm is fastened on the same shaft as one of these spiral gears and the whole mechanism is held in a rocker which throws the work in and out of mesh with a rack in the table. The worm has at all times five teeth in working contact with the rack.

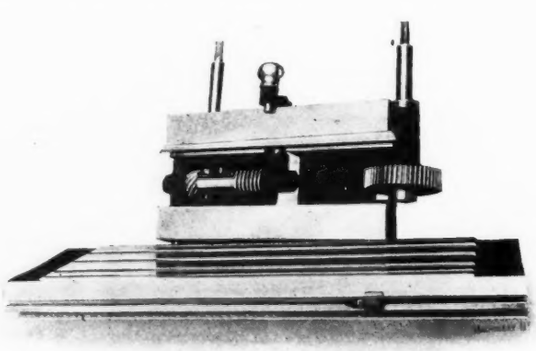


Fig. 7. Table and Saddle of Chicago Hand Miller

The design of the gear box is shown in Fig. 8. The feed gear mechanism consists essentially of a set of planetary gears contained in a compact case. Through this set of planetary gears the desired reduction of the spindle speed is obtained to give the proper feed for the table. The feed mechanism is

extremely simple and yet very effective. The cone pulleys which transmit the power from the spindle to the feed gear box are interchangeable, so that six changes of feed are obtainable.

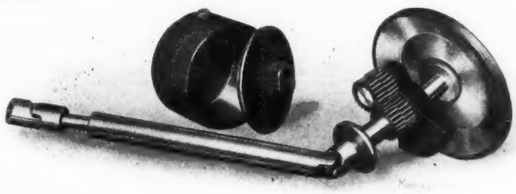


Fig. 8. The Simple Gear-box Parts of the Chicago Hand Miller

The counter-shaft furnished with the machine has self-oiling shaft bearings and it is not necessary to refill the oil chambers more than once a year. This feature alone is of great importance as it eliminates the usual counter-shaft troubles.

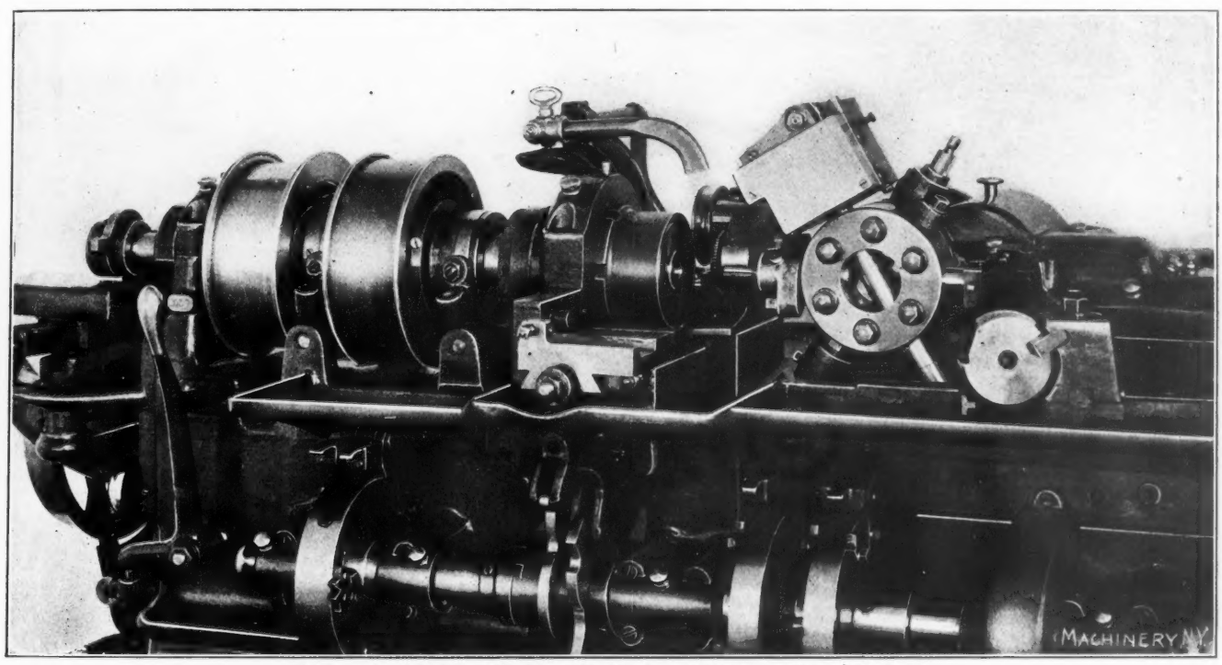


Fig. 1. Automatic Screw Machine with Attachment for Cutting Helical Steel Gears

Messrs. Hill, Clarke & Co., of Chicago, Ill., are the selling agents of this machine and it may be seen in operation in the demonstration shops of this concern.

ATTACHMENT FOR CUTTING HELICAL STEEL GEARS

In the April, 1909, issue of MACHINERY an article was published entitled "Cutting Helical Gears on the Brown & Sharpe Automatic Screw Machine." This described the tools and methods employed in the unusual operation of cutting helical gear-teeth in the screw machine. As will be remembered, this was done by running a revolving gear, having teeth of such shape as to mesh properly with the finished work, over the revolving blank; the face of the gear was ground, and set in the same plane with the axis of the work, thus providing a cutting edge which formed the teeth in the blank. The tool illustrated herewith, made by the Brown & Sharpe Mfg. Co., Providence, R. I., works on the same principle, as will be understood from the following description. Certain very interesting changes have been made in its construction, however, to fit it for heavy cutting in steel, the former tool being better adapted to work on brass and similar materials.

In the original attachment, the cutter was driven from the work by a three-cornered center, which was forced by spring pressure into the bore of the blank. For cutting steel it was found unsafe to trust this, so another, and very ingenious, expedient was resorted to. On the rear cross-slide in Fig. 1 is shown mounted a milling attachment. Just previous to the tooth-cutting operation, the work spindle is stopped, and the revolving cutter of this attachment is brought up across the outer end of the unfinished blank, milling away one side of it, not quite to the center, as shown in Fig. 2. The milling attachment is then withdrawn, the work-spindle is started up, and the tooth-cutting tool is brought into action. The pilot of the driving spindle *A*, Fig. 4, enters the bore of the work. To *A* is pinned the clutch *B*, having a single tooth, which engages the cut or recess in the work, and thus drives the spindle *A* and the connected train of gears. After the cutting of the teeth, the hub of the work is faced off as shown to the right, Fig. 2, thereby removing the milled recess. This method gives a drive strong enough for the heaviest duty, up to the point of breakage.

The principle of operation is the same as in the case of the original tool. As the attachment is fed onto the work, the spindle *A* (Fig. 4) is driven by the means just described, clutch *B* being held in engagement by the pressure of a long spring in the shank of the tool. A long worm *D*, keyed to the spindle *A*, and moving longitudinally with it, engages a worm-wheel *E*, which is keyed to an arbor carrying driving gear *F* (Fig. 3) at the outer end. This latter, through idler *G*, drives gear *H*, which is keyed to the cutter spindle. The cutter *J* is thus driven in synchronism with the rotation of the work.

As described in the previous article, provision is made for keeping the cutter and work in step with each other during the longitudinal feeding of the turret slide. As the attachment is pushed over the work, spindle *A*, clutch *B* (in engagement with it), and worm *D* are pushed back against the pressure of the spring in the shank of the tool. This backward movement, through the axial movement of *D*, rotates worm-wheel *E* in just the right ratio to keep the cutter in step with the work. The cutter *J* and the work are thus always in step with each other, whatever the rate of rotation of the work, or the feeding movement of the attachment. The slow forward feeding of the latter over the work thus causes the hardened and ground face of the cutter *J* to form teeth of the desired shape in the work.

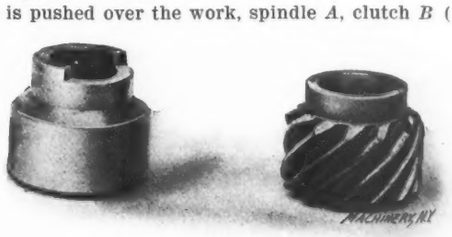


Fig. 2. Blank with Recess for driving while Teeth are cut, and Finished Gear

A number of adjustments are provided in this improved attachment, which tend toward increased convenience and accuracy. The spindle of worm-wheel *E* and gear *F* is mounted in an eccentric sleeve, which may be rocked by suitable adjusting screws to take up all back lash between *D* and *E*, and still leave a running fit. Sector *K* is pivoted to a hub on this eccentric sleeve, so that *G* is always in proper mesh with *F*,

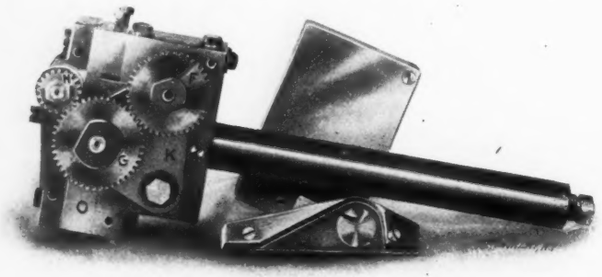
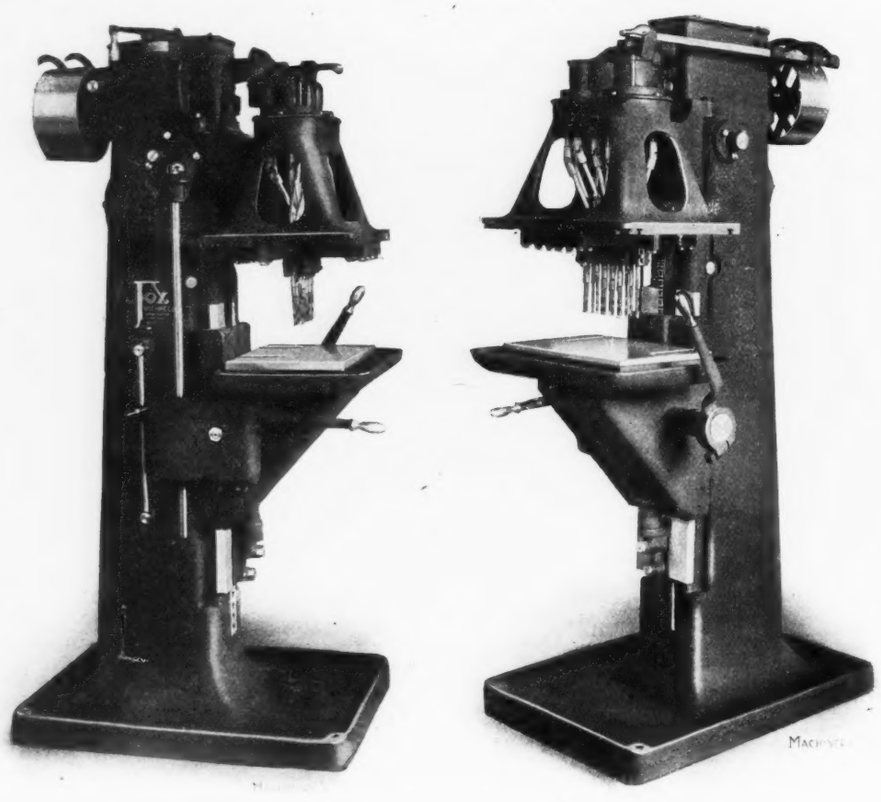


Fig. 3. Front Side of Spiral Gear-cutting Attachment for Steel Gears, showing Gearing

and so that it may be adjusted to properly mesh with *H*. A screw locks this adjustment.

The cutter spindle is mounted in a slide *M*, which is adjusted vertically to give the desired pitch diameter for the finished gear teeth. The overhanging end of the spindle is supported by the outboard bearing *N*. Slide *M* is supported, in turn, on cross-slide *O*, which may be adjusted horizontally



Figs. 1 and 2. Fox Universally Adjustable Multiple Spindle Drill

to bring the face of the cutter in the same plane with the axis of the work. Both the vertical adjustment for diameter and the horizontal adjustment for centering the cutter are effected by fine pitch adjusting screws; when made, the adjustments are firmly held by clamp bolts.

FOX ADJUSTABLE MULTIPLE SPINDLE DRILL

The accompanying illustrations show two views of the No. 2 Fox universally adjustable multiple drill, a description of the various features of which is given below. This machine is built and placed on the market by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich.

The machine is intended for drilling any number of holes up to sixteen, simultaneously. Each drill is driven through a universal joint, the drill spindles proper having an independent vertical adjustment of two inches, so that even though the drills may be of different lengths, they may be all set so as to start at the same time. The spindles are driven entirely through gears, four speed changes being obtainable.

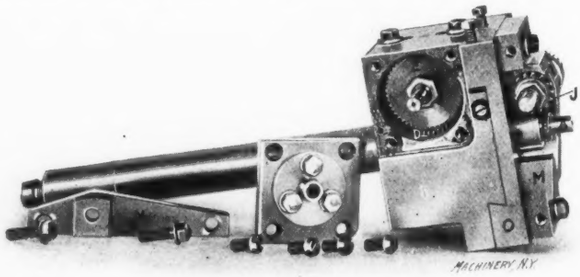


Fig. 4. Rear View of Attachment showing Driving Clutch, Worm-gear and Tooth-cutting Tool

The main drive consists of a loose and tight pulley having a 4-inch belt. The pulleys are 14 inches in diameter and are so placed on the machine that a convenient arrangement for motor drive can easily be made.

The drill head is bolted solidly to the column and the feed is accomplished by raising the knee of the machine while the drills remain stationary in the longitudinal direction, capable only of the vertical adjustment, already referred to. The standard drill head is adapted for drilling holes within a rectangle 8 inches wide by 14 inches long, but the head may be varied somewhat to meet special conditions. The main driving shaft runs at a constant speed and the feed mechanism is operated directly from this shaft. Five changes of feed are obtainable, and as the whole feed mechanism is operated by means of gearing, it is entirely positive in its action. An automatic trip is provided so that at the proper time the feed is thrown out, and then the table returns automatically to its lowest position. An adjustable buffer is provided so as to eliminate the shock when the table descends to the required position on the machine. The knee may be operated either by hand or power feed through a steel pinion meshing with a wide steel rack bolted to the face of the column. This latter is of a cored-out box section and is provided with a very substantial base having an oil pan along the edges; the table is also provided with very liberal oil channels along its outer edges. The knee is made of a full box section to insure sufficient strength and eliminate vibration. The entire machine is constructed on the unit system, each of the various units being attached to the main frame.

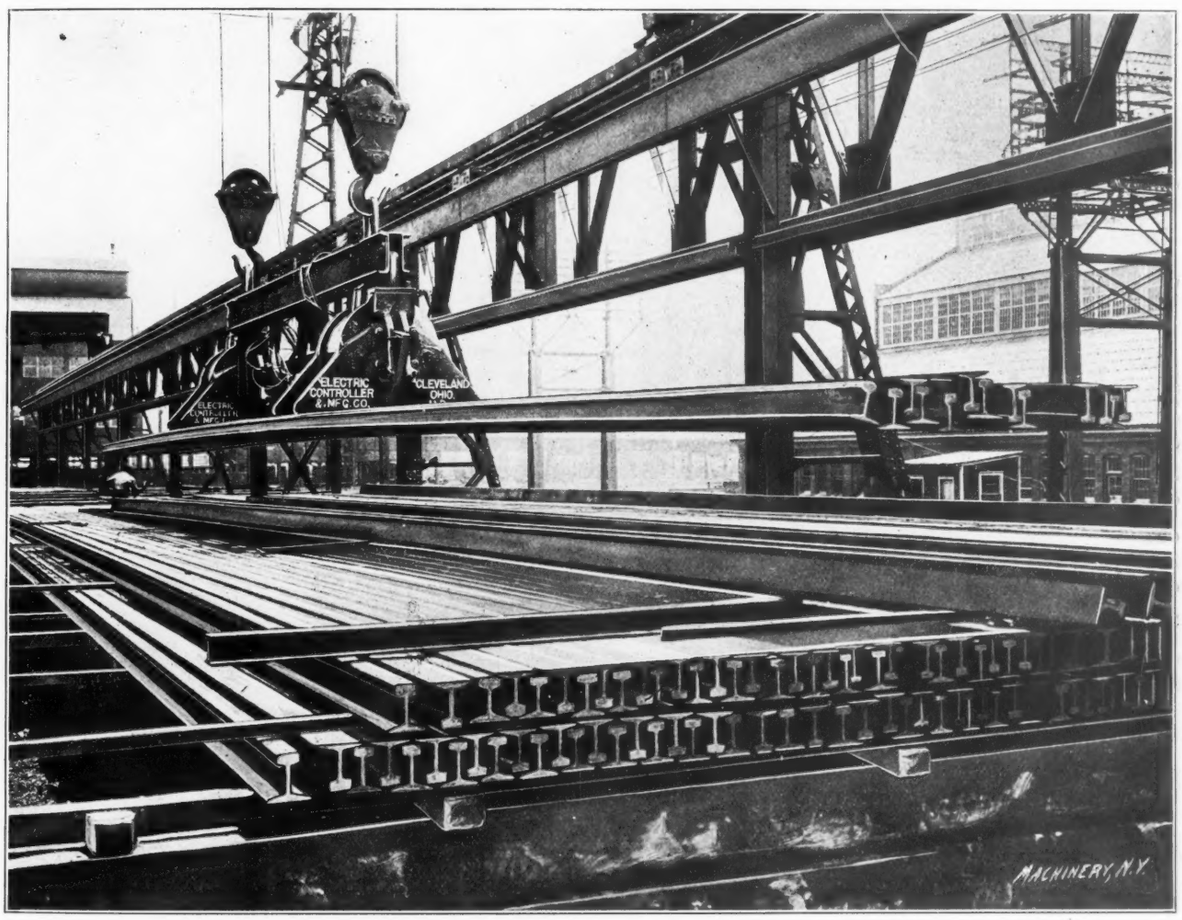
Spindles, shafts, etc., are all finished in the grinding machine. All sliding bearing surfaces are carefully scraped, and the drill spindles are made of high grade steel running in bronze bearings. The gears are all made of steel or bronze, and the principal steel gears are case-hardened.

The machine, as regularly furnished, will drive from 1/16 to 3/8-inch drills. The latter size drills require somewhat heavier spindles and universal joints than the former. The machine may, however, be furnished for special requirements to drive sixteen 3/8-inch drills, twelve 1/2-inch drills, ten 5/8-inch drills, and eight 3/4-inch drills.

RAIL-LIFTING MAGNETS

An improved design of rail lifting magnets brought out by the Electric Controller & Mfg. Co., of Cleveland, O., was illustrated and described in detail in the December, 1908, issue of MACHINERY. The same company has lately completed some very large lifting magnets for the handling of the entire output of the rail mill of the United States Steel Corporation's plant at Gary, Ind. This rail mill is of the most modern design in every respect and electric power has been used throughout for driving purposes. It was therefore a logical development to handle the finished rail by lifting magnets, provided a successful magnet could be designed. The difficulty met with in the design of the magnet was that, while it was desirable from the standpoint of rail mill and railroads alike to ship rails in locked sections, this arrangement of the rails made it particularly difficult to handle them with a magnet, the difficulty arising from the fact that the top layer of the rails practically short circuited the magnet field, and the magnets had to be very powerful and carefully designed in order to have sufficient strength to lift the bottom layer. Successful magnets were, however, furnished by the Electric Controller & Mfg. Co., and in the accompanying illustration one of these magnets is shown in operation. The magnets are capable of lifting locked sections of both 33- and 60-foot rails having an aggregate weight of 15 tons.

The advantages of using lifting magnets for work of this kind may be summed up as follows: Sufficient labor can be dispensed with to make the application commercially profitable as regards cost; a large saving in time of handling is effected; and as there is no possibility of bending the rail when loading by magnets, loss on this score is eliminated.



Electric Controller & Mfg. Co.'s Rail-lifting Magnets in Use lifting 60-foot Rails

MACHINE FOR HOBBING TAPS

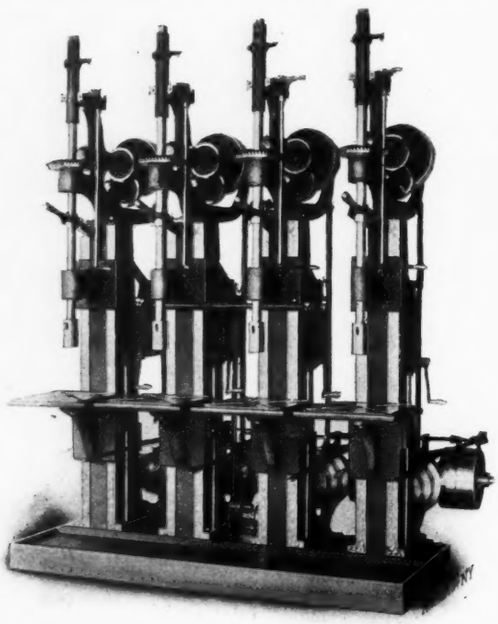
A new type of drill press, specially designed for use in the manufacture of taps, is shown in the accompanying illustration. The machine is built by the Hoefer Mfg. Co., Freeport, Ill., and embodies several interesting features which, together with the simplicity of action of the machine, ought to make it valuable for the purpose for which it is intended.

The machine resembles in many respects an ordinary drill press, but it differs notably in that the automatic feed is obtained by means of a lead-screw on the upper end of the spindle, which for this purpose is extended through the crown gear. The upper end of the spindle is turned down to a smaller diameter, and the lead-screw, consisting of a threaded sleeve, is fastened on the spindle by means of a lock nut. The lead-screw is removable, so that in each case it has the same lead as the tap to be threaded.

The tap blank is inserted in the vertical spindle in the same way as the tap itself would be inserted in a drill press used for tapping, whereupon the blank is driven through a die bolted to the table below. The tap blank passes through two dies, one for roughing and one for finishing. When the threaded portion of the tap blank has passed through the die, the special fixture or chuck holding the tap blank releases its hold on the shank, and the tap drops through a hole in the table. At the same time an adjustable dog clamped on and revolving with the threaded sleeve or lead-screw throws out of mesh the nut which engages the sleeve, whereupon the spindle returns to its original position, automatically, actuated by a counter-balance weight. The machine is then ready for another blank. The nut engaging with the sleeve is again thrown in mesh by means of a hand lever on the side of the lower spindle bearing.

The lower end of the spindle is provided with a Morse

taper into which is fitted a special fixture for holding the square head of the tap blanks. An interesting feature in connection with the spindle end is the special method employed for cutting the slot required for removing the Morse taper shanks. Most manufacturers make slots for drift pins by drilling three holes through the spindle and then working out the remainder of the metal by means of a chisel. In the present case, however, the slots in the spindle head are milled out on a machine made for that purpose with two milling cutters working one from each side simultaneously. This results in a central and smoothly finished slot.



Hoefer Mfg. Co.'s Machine for Threading Taps

The machine as shown in the accompanying illustration is provided with four spindles and thus provides for two sets of dies. One man can easily operate a machine of this type. Each of the spindles is attached to an independent column, and is equipped with its own independent driving mechanism, although all four columns are bolted to the same baseplate. As will be seen from the illustration, the columns supporting the spindle heads and driving mechanism are of the box type, in order to provide strength. The upper head is fitted with an additional brace supporting the outer end of the cone pulley shaft. One oil pump supplies oil to all the four spindles, and drainage is provided from the tables to the oil pan base so that the oil can be used over and over.

Due to the fact that the threading of tap blanks does not require high speed, the back-gears are designed to be left permanently in mesh and changes of speed are made only by shifting the belt on the cone pulleys. Each lower cone pulley is driven at right angles from a shaft having a loose and tight pulley, so that each spindle can be stopped independently by means of the belt shifting levers projecting through under the tables. Each table can also be raised and lowered independently of the others by means of a screw passing through a nut attached to the table and provided at its upper end with a bevel gear drive and crank.

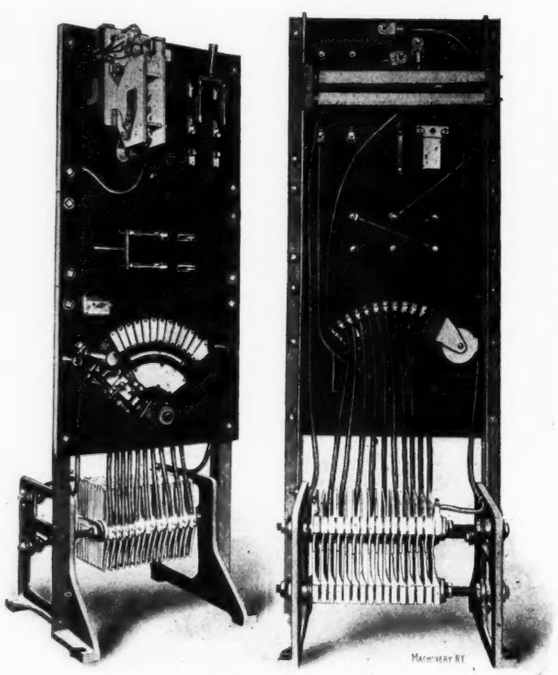
A NEW LINE OF MOTOR STARTERS

A new line of motor starters has been brought out by the Electric Controller & Mfg. Co., of Cleveland, O., one example of the new type being shown in the accompanying half-tone, where both a front and rear view are illustrated. The new design has been brought out on account of the demand for a motor starter of rugged construction. The improvement on previous types is embodied in the following features. The magnetic switch can be closed only by bringing the arm to the "off" position, thus preventing injuries and overloads to the motor upon the return of voltage after voltage failure. The magnetic switch can be held closed to the arm on any accelerating step only by holding in a push button; this prevents any of the starting resistance being permanently left in the circuit and thereby burning out the resistance. Finally, the magnetic switch will maintain itself closed only when the arm is at the "full-on" position.

The new line of starters is essentially of the mill type design. They are made in panels having supporting feet, as shown, and are completely self-contained; the dimensions of the different types vary only in height. Nothing projects beyond the slates, so that adjacent starters may be placed side by side, forming a continuous control board.

Experience has shown that the no-voltage protection secured by a spring return arm is open to the objections that the spring is likely to be either broken or weakened, so that upon voltage failure the arm does not return to the "off" position; in the second place, the contacts may become so roughened that the spring is not powerful enough to move the arm. Besides, an ignorant operator may block the arm in the "off" position, so that it is impossible for the spring to properly perform its function. If the arm is not returned to the "off" position upon voltage failure, the motor will be subjected to a damaging overload upon the return of the voltage. In this line of motor starters, therefore, the spring is eliminated, and the no-voltage protection is secured by a magnetic switch which opens upon voltage failure. The same magnetic switch in connection with an overload coil is used for securing overload protection. The feature for securing overload protection thus possesses the same arc breaking ability as a circuit breaker.

The resistance fingers, contacts, etc., used in these motor starters are of the same design and material as used in the builders' controllers for heavy service. The starters are furnished in several forms, beginning with a very simple type, and elaborated on to embrace such features as no-voltage release, overload protection, and separate and different overload protection for accelerating, the last-named feature allowing more current to flow through the motor during starting than during running. Since starting is relatively infrequent, the motor will not be injured by employing a starting current in excess of the running current. This feature is of particular value when the motor is connected to loads having great inertia, such as a hot saw or press with a heavy fly-wheel, where the mere acceleration of the load demands a considerable expenditure of work. By allowing more current to flow through the motor during starting, the starting time will be materially reduced, which in many instances is of particularly great importance.

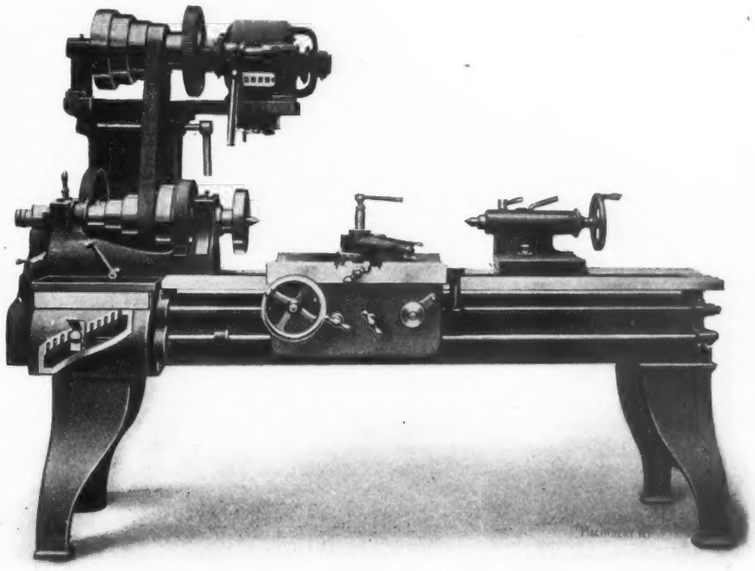


Front and Rear Views of the Electric Controller & Mfg. Co.'s Mill Type Motor Starters

DAVIS 16-INCH ENGINE LATHE WITH MOTOR ATTACHMENT

In the July issue of MACHINERY, reference was made to a 14-inch lathe built by the W. P. Davis Machine Co., Rochester, N. Y. The accompanying illustration shows a 16-inch by 8-foot engine lathe, built by the same company, provided with a motor attachment. This latter can be attached to any size or type of lathe and is of a very simple design. A small lever is placed directly under the table on which the motor and counter-shaft are mounted; by means of this lever the belt can be tightened from time to time and no lacing is required. A friction clutch is provided in the counter-shaft, attached directly to the inside of the large spur gear. By means of this friction clutch the counter-shaft can be stopped and started as required without stopping the motor.

A quick change feed device is provided on the lathe by means of which any thread ranging from 3 to 40 threads per inch can be cut, and any feed required for turning obtained. A feature of considerable convenience and importance in this lathe is introduced in form of a small dial attached to the right-hand side of the carriage, by which, when cutting threads, a nut can be opened and closed on the lead-screw, so as to "catch" the thread at the proper moment.



Davis 16-inch by 8-foot Motor-driven Engine Lathe

HANDY SHRINKAGE RULE

A handy shrinkage rule, as shown in the accompanying illustration, has been brought out by the Keuffel & Esser Co., Adams and Third Sts., Hoboken, N. J. It is intended to fill the demand for an accurate, well finished shrinkage rule at a moderate price. The particularly desirable feature of this

Keuffel & Esser Shrinkage Rule

shrinkage rule is that each of the four edges is graduated in 16ths, instead of in 8ths, 10ths, 12ths and 16ths, on respective edges, as is the case with the old style shrinkage rule. All the edges are numbered from left to right, so that the rule is always in proper position for use. The rule is two feet long, nominal size, the graduations being made in four different scales for 12.1, 12 1/8, 12 3/16 and 12 1/4 inches shrinkage measure, respectively, to the foot.

* * *

A German company has, according to the *Scientific American*, placed on the market a special electric generating equipment adapted to be operated by wind power. The installation comprises a dynamo and a storage battery, the latter serving to store the excess power until such time as it is required. The apparatus is entirely automatic, and requires absolutely no attention except in time of storm, when it is necessary to reduce the sail area of the wind wheel. A special regulator used with this apparatus automatically keeps a constant pressure on the lighting circuit, this being entirely independent of the number of revolutions of the dynamo or the condition of the storage battery.

* * *

A large power station is being built in Japan to furnish current for Tokyo, Yokohama, and adjacent cities and towns, which will have a capacity of 60,000 horse-power. The power will be derived from a 600-foot head of water. Six generators of the 3-phase, 25-cycle type, directly coupled to turbines, will be installed. Each turbine will develop 13,500 horse-power.

NEW MACHINERY AND TOOLS NOTES

SET OF COLD AND CAPE CHISELS: Lynn Tool Forging Co., Lynn, Mass. Set containing twelve tools consisting of hand-forged cold and cape chisels, including center punch. The tools are hand forged from 7/16-inch octagon steel, 5½ inches long, and placed in a cloth case with a place for each tool.

COMBINED MILLING AND BORING MACHINE: Cincinnati Punch & Shear Co., Cincinnati, O. This tool resembles a slab milling machine of the planer type, except that the spindle is provided with the longitudinal feed necessary for boring. This makes a combination tool which has been found very useful on a wide range of work.

TEST INDICATOR: J. L. Wolfe, Bridgeport, Conn. This indicator is readily applied to work in the lathe, milling machine, and shaper, or on the bench. It has a dial graduated to thousandths of an inch, and the scale covers 1/16 inch in either direction. It is simple and compact and for this reason suitable for work in the machine shop.

FRICTION DRIVEN DRILL PRESS: Barry & Zecker Co., Lancaster, Pa. In this machine the driving friction disk rests directly on the driving pulley, and the friction is secured by means of the weight of the disk. The position of the disk in relation to the driving pulley is controlled by the foot, as is also the position of the driving belt. The friction disk can easily be raised out of contact with the wheel, so that a single pulley drive can be used. The machine will drill up to 9/16-inch holes.

FLAT TAPER SHANK DRILL: Cleveland Twist Drill Co., Cleveland, O. This tool, known as the Paragon drill, is twisted from flat stock and provided with a flat shank, not twisted, but forged and ground to size. The shank is of uniform taper on the flat sides as well as on the rounded edges. A socket to take these flat drills is also provided, the outside of which fits the regular drill socket tapers. The strain on the flat shank is distributed over its total length, thereby eliminating danger of breakage.

DOUBLE BACK-GEARED ENGINE LATHE: New Haven Mfg. Co., New Haven, Conn. This lathe is built in two styles, either with quick change gear device or with a feed box having three feeds. Threads or feeds from 2 to 28 per inch can be obtained by the former, while with the latter, threads ranging from 1 to 28 per inch can be obtained with only nine change gears. The lathe has nine spindle speeds for each counter-shaft speed, which with a two-speed counter gives from 7½ to 333 revolutions per minute.

OIL BURNING FURNACE FOR HEAT TREATMENT OF STEEL: Tate, Jones & Co., Pittsburg, Pa. This furnace has been designed on account of the ease with which the temperature can be regulated in oil burning furnaces, and is of iron construction with fire-brick lining. The oil is carried in a tank at the side of the furnace and is forced into the burner from the tank by means of air pressure from the regular shop blast, or from a small blower placed at the side of the machine. The flame is so diverted that a uniform temperature is maintained in all sections of the furnace.

PLAIN GRINDING MACHINE: Modern Tool Co., Erie, Pa. This machine, known as the No. 12 grinder, is heavily designed and the head-stock and foot-stock are secured to the vertical rail

by special clamping devices. The automatic cross-feed gives a range from 0.00025 to 0.004 inch for each reversal of the table. The machine will grind straight or taper work up to 5 inches in diameter and 31 inches long, with any taper up to 1¾ inch per foot. The wheel is 12 inches diameter by ¾ inch face and the floor space 41 x 110 inches.

OVAL SOCKET BREAST DRILL: Lancaster Machine & Knife Works, Lancaster, N. Y. The distinguishing feature of this breast drill is the fact that its socket is provided with an oval taper hole for driving drills with oval taper shanks. This system of driving was described in the department of New Machinery and Tools in the September, 1908, issue of MACHINERY. The drills with the oval tapers are made by the Whitman & Barnes Mfg. Co., of Akron, O., who offer them as a regular article of trade independent of the breast drills here mentioned.

COMBINED SURFACE AND TOOL GRINDER: XX Century Tool Co., 1289 Marquette Road, Cleveland, O. The most prominent feature of this machine is the height of the spindle and table, the former being 51 inches from the floor, thereby bringing the work so high that the operator does not have to stoop to watch it. The machine is designed especially for grinding screw machine and other tools with parallel surfaces, and can also be used as a surface grinder for small work. The traverse of the table is 6 inches, the cross-feed 3 inches, and the vertical adjustment 4 inches.

RAPID BLUE-PRINTING MACHINE: Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa. A special feature of this blue-printing machine is the rapidity with which the prints can be produced. When used in pairs, the light from one set of lamps will be sufficient for two machines, and the maximum capacity of blue-prints is then 16 feet per minute for the two machines, at the cost of one set of lamps. Each machine in a pair is independent of the other, and one can be run at its maximum speed for fast blue-printing while the other is run slowly for sepia or negative work.

ELECTRIC RECORDING PYROMETER: Edward Brown & Son, 311 Walnut St., Philadelphia, Pa. This instrument is constructed for use in conjunction with a thermo-couple, but the type of recording gage used can also be employed for very accurately recording pressures of steam and air, voltage, etc. When used as a pyrometer, the instrument can be supplied for any desired range in temperature, and the record charts can be made to revolve once in twenty-four hours, or once in seven days, as preferred. The instrument is very simple in its construction, which is of great advantage when used under regular industrial conditions.

GRINDING AND POLISHING MACHINES: Adamite Surface Machine Co., 217 High St., Newark, N. J. These machines are both of the vertical and horizontal type, equipped with cloth belts charged with abrasive. The vertical type of machine has two belts, one for roughing and one for finishing the metal being ground. The belt containing the abrasive runs over an endless leather belt, both belts being supported back of the work, which rests on a table in front. The horizontal type is better adapted to work which is more easily handled by holding it down onto the belt. A special machine is built for polishing tubing, shafting and similar work.

HEAVY POWER PRESS: George A. Ohl & Co., 157 Oraton St., Newark, N. J. This machine is of powerful design capable of cold bending up to ½-inch soft steel to a right angle, and is designed for forming the thick sheet metal work which enters into the construction of steel passenger cars, metal furniture, etc. The openings in the housings through which the work passes are 30 inches wide by 15 inches high. The stroke is 4 inches with a position adjustment of 4 inches to suit different heights of dies. The height of the machine is 16 feet over all. It occupies a floor space of 16 by 8 feet and measures 12½ feet between the housings. The machine weighs 108,000 pounds and requires 35 H. P. for driving.

PORTABLE ELECTRIC BREAST DRILL: Willey Machine Co., Jeffersonville, Ind. This is the smallest size in the line of breast drills built by the makers; the largest size with gear drive was shown in the November, 1908, issue of MACHINERY. The main feature of this line of drills is the simplicity of construction, which is a most important matter in devices of this kind, which are often subjected to rough usage when in service. The present size is suitable for drilling holes up to ¼ inch in diameter. The entire machine can be easily taken apart by simply removing two nuts, leaving the whole mechanism open for inspection. The drill chuck is attached directly to the armature shaft, and a snap switch located on the side of the frame makes the starting and stopping of the drill very convenient.

* * *

A New York concern—Wyckoff, Church & Partridge—has taken the agency for the Herring-Curtiss aeroplane, and advertises machines for sale, subject to delivery within forty days from date of order. This announcement indicates that the flying machine proposition has reached the commercial stage so far as supplying the wants of amateurs is concerned, at least.

STANDARDS FOR RECIPROCATING STEAM ENGINES FOR ELECTRICAL PURPOSES

The Engineering Standards Committee of Great Britain has just issued a report on reciprocating steam engines for electrical purposes, which contains some propositions for standardization which may well be considered in this country as well. The steady increase in steam pressures that has marked the development of the steam engine during the last few decades has led to a certain specific, yet somewhat loose, classification of types, which at times is rather confusing. The committee has, therefore, defined the meaning to be attached to such phrases as low pressure, high pressure, extra high pressure, medium vacuum and good vacuum, etc. In respect to steam pressures the following standards for pressures measured at the throttle valve are suggested:

	Pounds per Square Inch Gage Pressure
Low pressure	100
Intermediate pressure	150
High pressure	200
Extra-high pressure	300

With respect to vacuum measured by mercury column at the exhaust flange of the engine, the following values are suggested as definitions of "medium" and "good":

	Pounds per Square Inch, Absolute.
Medium vacuum	2.5
Good vacuum	1.5

With respect to speeds of engines the following table is given to indicate the limits of the terms "slow," "medium," and "high" speed in reference to revolutions per minute and rated output:

Rated Output in Kilowatts	Revolutions per Minute at Rated Output		
	Slow	Medium	High
30	...	...	625
40	...	...	600
50	...	...	575
60	...	...	575
80	...	...	525
100	107	250	500
150	107	250	428
200	107	250	375
250	107	250	375
300	94	214	375
400	94	214	375
500	94	214	300
750	83	188	250
1000	83	188	250

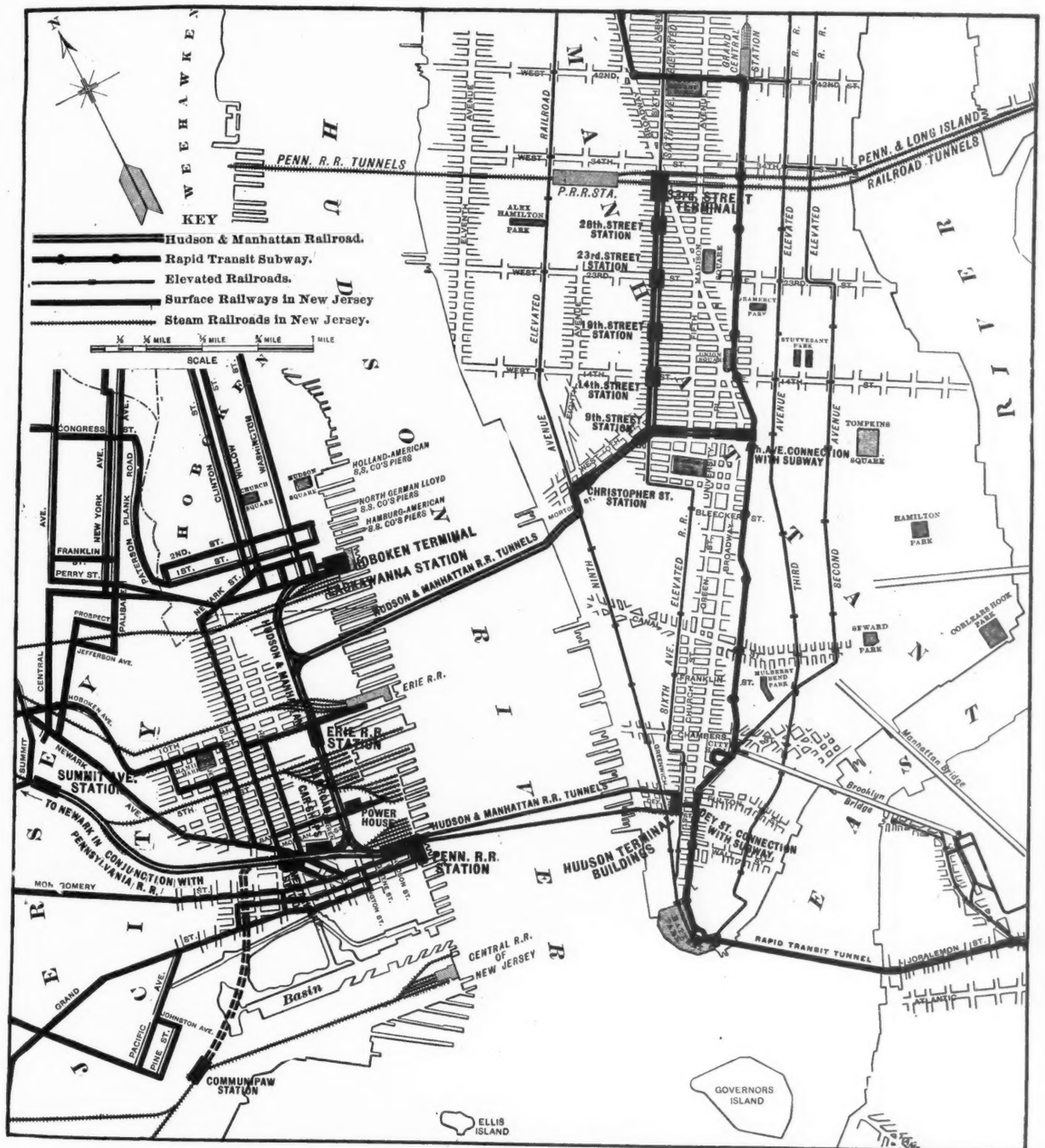
Regarding the size of engines to be used for different sizes of generators the committee lays down the general rule that the engine shall be capable of driving the generator continuously at all loads up to the rated output and for at least two hours at twenty per cent above the rated output of the generator without undue heating of the bearings, or other mechanical trouble. It is also suggested by the committee that the size of engine cylinders should be such that the mean pressure in pounds per square inch referred to the low pressure cylinder at full load should not exceed that indicated by the table below:

Steam Pressure, Pounds per Square Inch	100		150		200		300	
Class of Engine	Compound	Triple	Compound	Triple	Compound	Triple	Compound	Triple
Non-condensing	35	..	44	42	51	48	59	56
Condensing, medium vacuum	32	29	40	36	45	40	50	45
Condensing, good vacuum	30	27	37	34	41	37	46	41

Regarding the speed variation it is stated that the maximum temporary variation in speed due to the load being varied gradually, or by steps not exceeding twenty per cent of the rated load, should not exceed five per cent of the standard full load speed.

OPENING OF SECOND HUDSON TUNNEL

The downtown tunnel of the Hudson & Manhattan Railway Co., connecting the Hudson Terminal in New York and the Pennsylvania Railroad terminal in Jersey City, was opened to public traffic July 19. The completion of this tunnel adds another link to the great transportation system that will eventually connect all the railroad terminals in New York City, Jersey City and Hoboken, with the exception perhaps of the West Shore R. R. The tunnel opened February 25, 1908, connects with the Erie R. R. When the system is completed it will be possible for a traveler to reach any of the railroad terminals of New York by the tunnel route with the exception noted above, on payment of a five-cent fare. The tunnel system will connect with the New York Subway at Broadway and 9th Street, and a foot-path tunnel will connect the Hudson Terminal with the Subway at Broadway and Dey Street. The two great tunnel systems will thus be connected so as to make emerging to the street unnecessary in a trip from Brooklyn or the Bronx to New Jersey.



Map of the Hudson & Manhattan Railroad Co.'s Tunnel System, showing also Subway, Surface and Elevated Railway Lines

connects the Hoboken terminal of the Delaware, Lackawanna & Western R. R. with Christopher Street station and the stations on Sixth Avenue including 23rd Street. This line will soon be completed to the new Pennsylvania R. R. station at 33rd Street, and a franchise was recently granted for extending it to the Grand Central station on 42nd Street, the terminal of the New York Central and the New York, New Haven & Hartford railroads.

Early in August the link connecting the Pennsylvania R. R. station with the Lackawanna will be completed, which also

The Hudson Terminal consists of two great twin buildings on Church Street covering a large portion of the two blocks between Fulton and Cortlandt Streets. In the common basement of the buildings is a great concourse extending under Dey Street, and in the sub-basement are the tracks and passenger platforms. The machinery trade is interested in the Fulton building particularly because of the Machinery Club on the 21st and 22nd floors which has a large membership in the machine tool and other lines of machinery trade. It is possible for a member to enter an elevator at the club floor and emerge on

the concourse floor and take a train to Jersey without going onto the street. See MACHINERY, March and June, 1908.

It is estimated that the tunnel system will handle 100,000,000 passengers annually from the start, much of which will be new business, judging from the history of other New York transit improvements. The present ferry traffic across the Hudson is estimated at 128,000,000 annually, but it is not likely that there will be serious diminution of the ferry traffic until the railways have made the tunnel system a more closely connected part of their terminal systems. When that time comes, the total estimated capacity of the tunnels may be required, that is 220,000,000 passengers annually with eight-car trains operated at an interval of 1⅛ minute in rush hours.

The cost of the tunnel system will be about $70,000,000 when completed. It was begun in 1874 by D. C. Haskins, a civil engineer who conceived the idea of constructing a brick tunnel from Hoboken to New York. About 1,200 feet of the tunnel was built when the company failed and in 1880 the work was temporarily abandoned. In 1890 another company was organized with English capital and added about 1,800 feet to the part already built, when it also failed and once more the enterprise was held up. In 1901 William G. McAdoo, a young Southern lawyer, became interested in the project of rapid transit to the Jersey shore, and organized the present company. The old method of construction using a brick lining was abandoned. The present tunnel is lined with cast iron rings made in sections and bolted together. The chief engineer is Charles H. Jacobs, to whom much credit is due for the rapid progress of the work and the remarkable freedom from serious accidents to life and limb that has characterized this gigantic and dangerous undertaking.

SHOP DOOR CLOSING DEVICE

The heating of machine shops, factories, round-houses, and other buildings having large doors is seriously retarded by the leakage of volumes of cold air in over the doors at the top. The ordinary large sliding or swinging door almost invariably bulges at the top making a crack of considerable width through which the cold air blows in greater or less volume according to the exposure, and velocity of the gale. During the past few years the heating of large shops and round-houses has received a great deal of attention, and no modern structure is considered complete without adequate means of heating. The old idea that the men should keep warm by hustling has been generally discarded and now every up-to-date factory manager realizes the importance of providing as nearly as possible a uniform, comfortable temperature in all work-rooms. The cost of heating large buildings in northern latitudes is a heavy item, and practical means that will shut out the cold air where it should not enter merit attention.

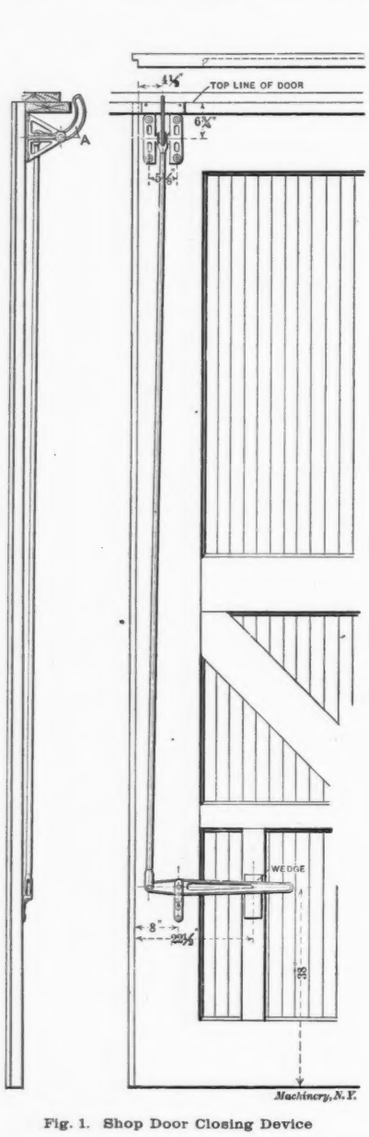


Fig. 1. Shop Door Closing Device

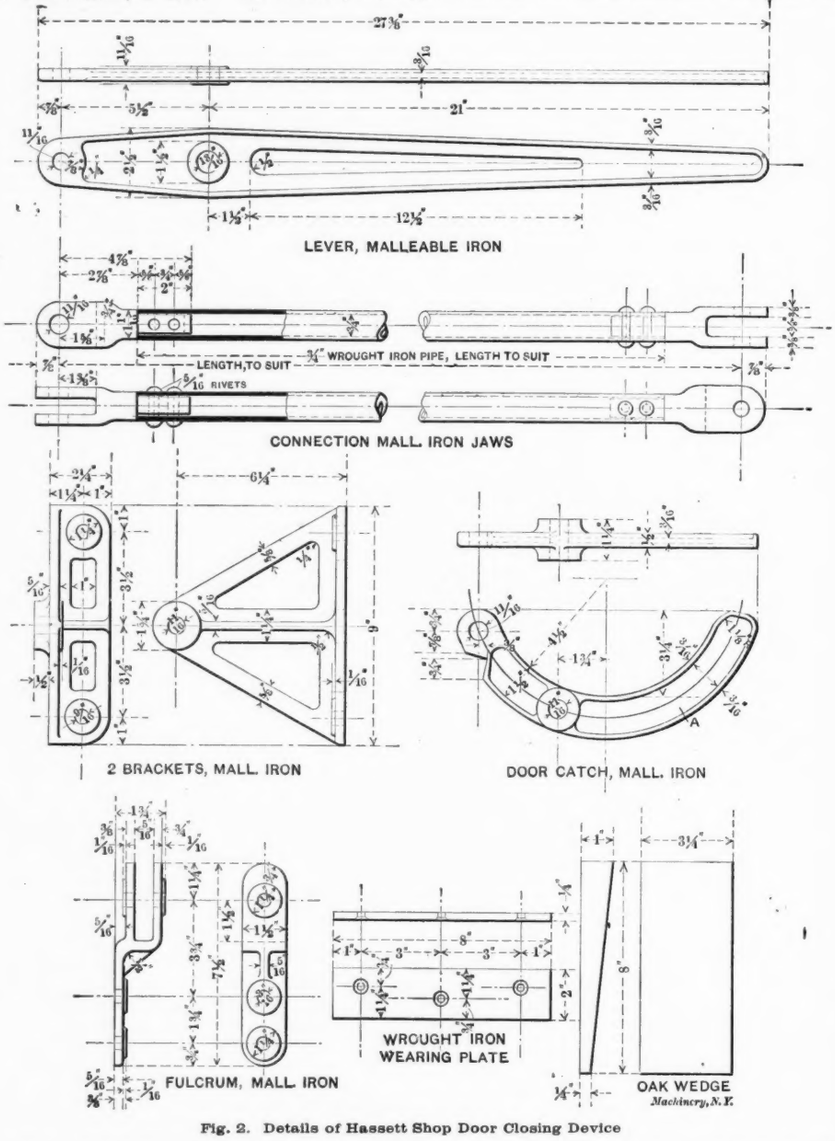


Fig. 2. Details of Hassett Shop Door Closing Device

Realizing the serious loss that results from bulging doors in railway shops, as well as in other works having large doors, through the lack of close fit at the top, Mr. J. C. Hassett, technical instructor of apprentices of the Erie Railroad, Meadville, Pa., has devised the shop door closing device illustrated in Figs. 1 and 2 in which the action of the device and the details of the component parts are illustrated. As will be seen, the arrangement provides means by which the door is clamped and forced solidly against the jamb at the top by means of the curved piece *A* which is worked by a connection and lever conveniently located on the door. The connecting rod may be of any length required to suit the door height.

THE RESULT OF ONE YEAR OF THE FITCHBURG IDEA

Last September a co-operative high school and industrial training course was inaugurated in Fitchburg, Mass., as described in the October number of MACHINERY. It was an adaptation of Prof. Herman Schneider's idea worked out in the University of Cincinnati and known as the co-operative industrial course, but modified to suit the local conditions of Fitchburg and its high school. The course was conducted under the direction of Prof. William B. Hunter, and the result of the work has fully justified the enthusiasm of Prof. Hunter and others responsible for the initiation of the work and its successful conduct.

The course of study was patterned after that in the University of Cincinnati, it being a form of apprenticeship system whereby the boys receive instruction in the shop one week and instruction at the school the next week. The course is of four years duration and the first year is spent wholly in the school, thus leaving three years for the alternate weekly work in school and shop. The shop work consists of instruction in the operation of lathes, planers, milling machines, punch and shear work and other mechanical work within the ability of apprentices. The boys are paid for their work in the shop. For the first year the rate of payment is 10 cents per hour, for the second year 11 cents and the third year 12½ cents per hour, making $5.50 per week or $165 for the first year, $6.05 per week or $181.50 for the second year and $6.87 per week or $206.25 for the third year. Thus the boy in this course may earn a total of $552.75 in three years while obtaining a practical and theoretical education.

The principal, instructors, students and manufacturers of Fitchburg speak highly of the results of the initiatory year. The *Fitchburg Daily News* for June 17 gives an extended account of the close of the school year with a list of eight questions propounded to twenty-two boys and the answers received from fourteen, which will be found of interest by those closely concerned with industrial education.

* * *

Louis Bleriot, a Frenchman, crossed the English Channel Sunday morning, July 25, on his aeroplane. The distance across the channel is twenty-one miles, and the trip was made in thirty-seven minutes, the rate of travel, therefore, being thirty-four miles per hour. The trip was without accident except at the landing when the machine was whirled around two or three times and the propeller broken by striking the ground. Bleriot wins the *Daily Mail* prize of $5,000 offered to the first man who performed the exploit. The Bleriot machine is a monoplane, there being only one supporting surface, as compared with the biplanes used by the Wright brothers, Curtiss, Farman, and others which have two superimposed planes.

* * *

PERSONAL

Perley E. Harey, master mechanic of the Chapman Valve Mfg. Co., Springfield, Mass., has resigned his position.

A Munch, manager of the railway department of the Northwestern Metal Mfg. Co., Minneapolis, Minn., has been elected a director and the secretary of the company.

H. C. Patterson has taken the position of electrical and mechanical engineer with the Illinois Traction System, vacated by the resignation of Mr. H. C. Hoagland.

Arthur Williams, chief inspector of the New York Edison Co., has been elected one of the Board of Trustees of the Museum of Safety and Sanitation, New York.

Fred E. King, Springfield, Mass., has resigned his position with the King Automobile Co., to become foreman of the tool room of the Dickinson Mfg. Co., of that city.

J. A. Bell has been appointed master mechanic of the Dubuque division of the Illinois Central R. R., with headquarters at Waterloo, Ia., succeeding R. J. Turnbull.

P. V. See, who until recently was in the employ of the Twin City Traction Co., of St. Paul and Minneapolis, has been appointed general foreman of the Illinois Traction Co.'s shops at Decatur, Ill.

The volume of studies of American life and labor, "Social Engineering," by Dr. William H. Tolman, director of the Museum of Safety and Sanitation, New York, has been translated into French.

S. L. Tallman & Sons have taken a lease from the administrator of the estate of the J. S. Spencer Machine Co., Springfield, Mass., and will continue the works as a jobbing machine shop as heretofore.

E. M. Haas, formerly connected with the Southern Illinois McKinley interests, has been transferred to Decatur, Ill., to fill the position of superintendent of the bridge and building department of the Illinois Traction System.

Coker F. Clarkson was elected assistant general manager of the Association of Licensed Automobile Manufacturers in June to fill out the term of Mr. C. E. Chalfant, who recently resigned as general manager.

A. P. Warner, vice-president of the Warner Instrument Co., Beloit, Wis., has purchased a Herring-Curtiss areoplane. Probably it will be fitted with a special anemometer connected with a Warner autometer to indicate the velocity of flight!

Leon J. Canova, Havana, Cuba, has been appointed, by President Gomez, director of the Bureau of Information, established at the beginning of the present fiscal year. Manufacturers interested in Cuban trade are invited to communicate with him.

Otto Shilling, formerly superintendent of the Peoria division of the Illinois Central R. R., will re-enter railroad work after being some time engaged in other business; he has taken the position of train-master for the Texas & Pacific Railway at Texarkana, Texas.

Dr. William H. Tolman, director of the Museum of Safety, New York, read a paper at the twenty-second convention of the National Association of Accident Underwriters, Hotel Clifton, July 13-16, Niagara Falls, New York, entitled "Perils of Peace, or a Safer America."

The jurisdiction of Frank Lane, chief electrician of the Wabash Railroad, Moberly, Mo., has been extended over the entire Wabash system, his headquarters being at Decatur, Ill. Mr. Lane's successor at Moberly is William Erwin, who has been night stationary engineer at the Decatur shops.

Benjamin Whittaker resigned as treasurer of J. H. Williams & Co., manufacturer of drop forgings, Brooklyn, New York, July 1, and will now give his entire time to the exporting business for the same company and others, with headquarters at 17 State St., New York.

Herbert V. Purman, formerly assistant superintendent of the National Manufacturing Co., Worcester, Mass., and more recently labor superintendent of the Corbin Motor Vehicle Corporation, New Britain, Conn., has returned to Worcester to act as general foreman of the Heald Machine Co.

William Threlfall has resigned his position of general manager of the Chapman Valve Mfg. Co., Springfield Mass. A number of the foremen gave Mr. Threlfall a banquet at the Worthy Hotel, June 8, at which he was presented with a handsome hunting case gold watch with suitable inscription.

August Kittleberger, who for the past fifteen years was associated with the Clayton Air Compressor Works, has been engaged by the American Air Compressor Works as superintendent of its Brooklyn plant. Mr. Kittleberger's long experience in the construction of air compressors and vacuum pumps has well fitted him for his new position.

Hugh M. Wilson, formerly editor and publisher of the *Railway Age*, became associated with the Barney & Smith Car Co., Dayton, Ohio, August 1, as director and vice-president. Mr. Wilson disposed of his publication business something more than a year ago, having recently returned to the United States after spending nearly a year in foreign travel.

Joseph H. Williamson, for eighteen years business manager of the Manufacturers' Advertising Agency, New York, and for seven years business manager of the Viennot Advertising Agency, Philadelphia, Pa., resigned from the Viennot Agency October, 1907, and up to April, 1909, had charge of the company's New York business on a salary basis. Mr. Williamson has now opened an office at 719 Temple Court, New York, where he will act as a representative of trade journals. He is well known to the publishers of trade journals in the United States, and any business entrusted to him will receive careful attention.

* * *

OBITUARIES

Gust. A. Dalin died at the Rockford Hospital, Rockford, Ill., July 10, aged forty-seven years. He was in partnership with his brother in the firm of Dalin Bros., machinists. He was the inventor of a friction drill, and was engaged in the manufacture of small milling machines. The business will be conducted by the brothers, A. G. Dalin and S. Dalin. Mr. Dalin is survived by a mother, four sisters and three brothers.

A. Bradshaw Holmes, secretary and treasurer of the Independent Pneumatic Tool Co., and the Aurora Automatic Machinery Co., Chicago, Ill., died June 30, 1909, from injuries received by accidentally falling from the piazza of his hotel. Mr. Holmes was well known in the pneumatic tool business, having been connected with the Standard Pneumatic Tool Co., and the Rand Tool Co. for a number of years prior to his connection with the Independent Pneumatic Tool Co., of which concern he was secretary and treasurer since its organization. He was thirty-one years old and unmarried.

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Providence, Rhode Island, U. S. A.

B. & S. Automatic Gear Cutting Machines

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Correctly Designed, Accurate Bearing Surfaces.
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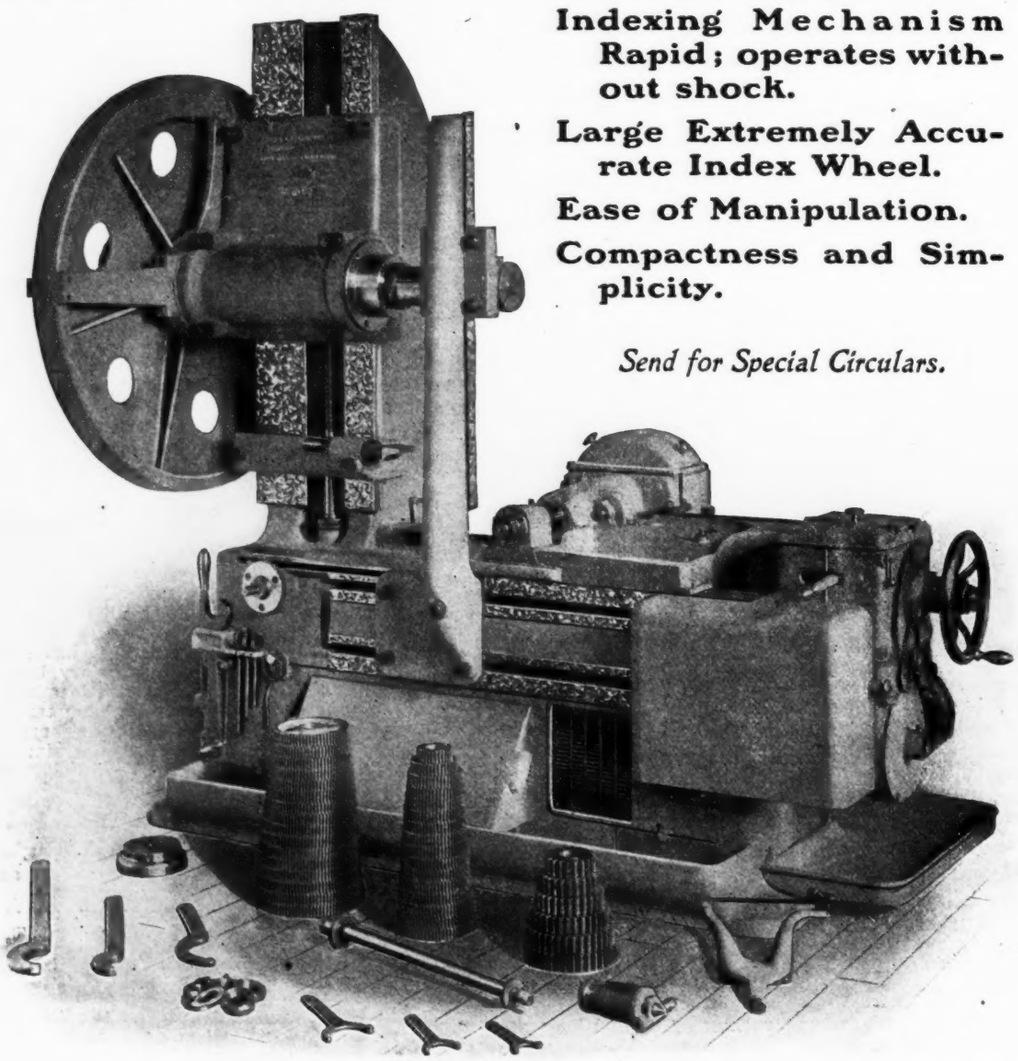

No. 6 Automatic Gear Cutting Machine.

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B. & S. Wire Feed and Plain Screw Machines

Correctly Designed and Carefully Constructed Machines of Great Accuracy and Remarkable Durability.

IMPORTANT FEATURES

Rigid Construction of All Parts.

Economical Consumption of Power.

Independent Stop for each Hole in Turret.

Vertical and Transverse Adjustment for Turret Slide.

Graduated Scale on side of Turret Slide.

Adjustable Stop on Cross Slide.

Gearing Fully Enclosed.

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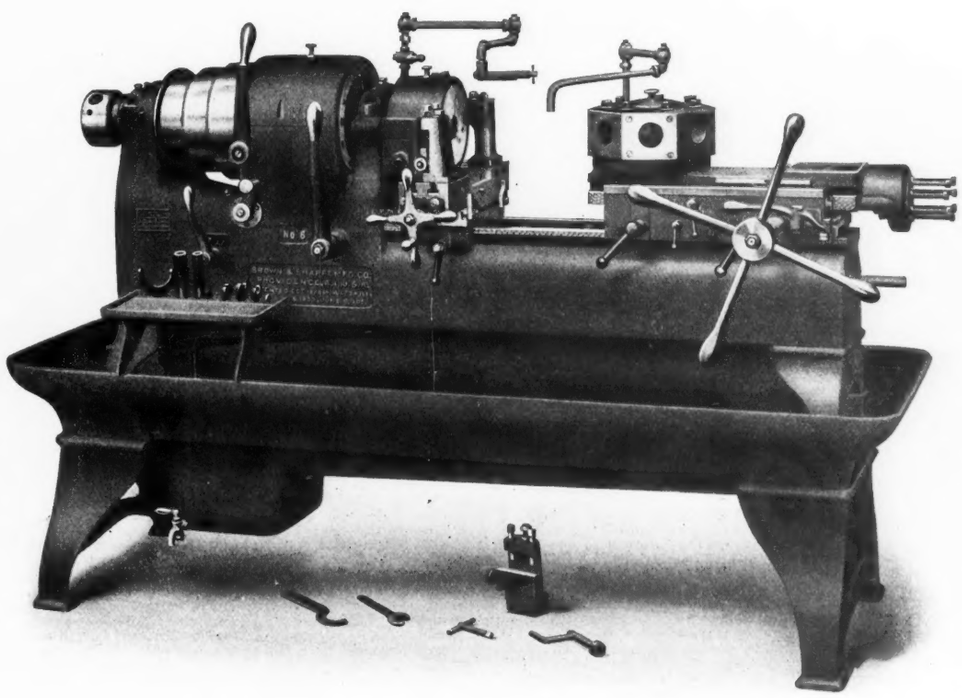


No. 6 Wire Feed Screw Machine.

COMING EVENTS

August 9-14.—Seventeenth National Irrigation Congress, Spokane, Wash., for the consideration of an action on irrigation, drainage, forestry, good roads, deep waterways, and home building. Arthur Hooper, secretary, Board of Control, Spokane, Wash.

September 25-October 9.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one-hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the *Tribune* building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

September 27-October 1.—Autumn meeting of the Iron and Steel Institute, London. G. C. Lloyd, secretary, 28 Victoria St., London, S. W.

October 4-8.—Annual conventions of the American Street and Interurban Railway Association, American Street and Interurban Railway Accountants Association, American Street and Interurban Railway Engineering Association, American Street and Interurban Railway Claim Agents' Association, American Street and Interurban Railway Transportation and Traffic Association, American Street and Interurban Railway Manufacturers' Association, at Denver, Col. Bernard V. Swenson, secretary and treasurer, 29 West 39th St., New York.

October 12-13.—Convention of National Machine Tool Builders' Association, New York. P. E. Montanus, secretary, Springfield, Ohio.

October 14.—MACHINERY's seventh annual outing.

April 1-June 30, 1910.—American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Viewger, American manager, 50 Church St., New York.

SOCIETIES AND COLLEGES

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION held its seventeenth annual meeting at Columbia University, New York, and Pratt Institute, Brooklyn, June 24-26. The program included papers on technical education, features of engineering practice, etc., among which were: "Present Tendencies in Technical Education," President Frederick E. Turneaure, dean of the University of Wisconsin; "Highway Engineering," L. W. Page, director of the Office of Public Roads, United States Department of Agriculture; "The Relation of Engineering Education to Industries," Charles B. Going, editor *Engineering Magazine*; "Efficiency in Education," Prof. George F. Swain, Massachusetts Institute of Technology; "The Extension Work of the University of Wisconsin," Prof. Louis E. Reber, University of Wisconsin; "The Requisite Qualifications of an Engineering College Instructor," Oliver B. Zimmerman, Charles City, Iowa; "Employer's Requisites of Technical Graduates," Prof. Hugo Diemer, The Pennsylvania State College.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Boston, Mass., has appointed Dr. Harold Pender to the professorship of Theoretical and Applied Electricity which is connected with the Department of Electrical Engineering. Dr. Pender is a graduate of Johns Hopkins University and took the degree of Ph.D. at that university in 1901 under the direction of Prof. Rowland. He thereafter taught for a year and a half, during which period he completed the classical experiments of Prof. Rowland which demonstrated the magnetic effect of a moving charge of electricity. Poincaré, the eminent professor of the Sorbonne in Paris and a member of the French Academy, having suggested the desirability of these experiments being performed in Paris for the benefit of French scientists, the Carnegie Institution of Washington arranged with Dr. Pender to go to France for the purpose. Upon returning from France, where his experimental demonstration had been received with acclamation, Dr. Pender went into the employ of the Westinghouse Electric Co., and he has since been in regular engineering employ. He is recognized as notable in his work in mathematical and experimental physics. His teaching at the Institute of Technology will consist of a course for third-year undergraduate students and courses for graduate students in the more advanced theories of electric current flow and the electric transmission of power, in addition to the direction of experimental research by advanced students.

NEW BOOKS AND PAMPHLETS

STEEL SQUARE POCKET BOOK. By Dwight L. Stoddard. 159 pages, 3¼ x 5 inches, 150 diagrams. Published by the Industrial Publication Co., New York. Price, 50 cents.

This book on the use of the carpenter's steel square has passed into the second edition and has been partly rewritten and rearranged. New matter has been added, including about forty new diagrams. It treats of the uses of the steel square, showing how to cut rafters, lay out angles, and apply this indispensable tool generally to the many purposes required of it by the expert carpenter.

LESSONS IN TELEGRAPHY. By Charles H. Sewall. 88 pages, 5 x 7 inches. Published by D. Van Nostrand Co., New York. Price, $1.00.

This work is designed for use as a text-book in schools and colleges and for individual study, its aim being to furnish the student with not only the ordinary instructions in telegraphy necessary to learn the art, but to teach him what bad telegraphic habits to avoid. It contains sending and receiving exercises for commercial and railway business, press news, market reports, etc. The work contains much that the ordinary amateur never learns until he enters a commercial office, and for this reason should be highly useful to a class of learners who cannot readily acquire such advantages.

TABLES AND DIAGRAMS OF THE THERMAL PROPERTIES OF SATURATED AND SUPERHEATED STEAM. By Lionel S. Marks and Harvey N. Davis. 106 pages, 6½ x8¾ inches. Published by Longmans, Green & Co., New York. Price, $1.00.

The older tables giving the properties of saturated steam were based on the investigations of Regnault carried out more than sixty years ago. It has been apparent for some time that the total heat of dry and saturated steam as determined by Regnault's researches are below the correct values, and new determinations have been made. The new tables are based on the investigations of Dieterici, Smith Griffiths, Henring, Joly, Grindley, Griessmann, Peake, Knoblauch and Thomas. The book comprises tables of superheated steam temperatures, saturated steam temperatures, saturated and superheated steam, superheated steam at high temperatures, boiling points for thermometer calibrations, thermal properties of water, conversion tables, logarithms to the base of 10, logarithms to the base of *e*. Part III of the book is given up to discussion of sources of the data as follows: Absolute temperature, the specific heat of water, the mechanical equivalent of heat, the pressure-temperature relation, the specific heat of superheated steam, the specific volume of superheated steam, the total heat of saturated steam, the specific volume of saturated steam at high temperatures and the computation of the tables.

GEAR CUTTING MACHINERY. By Ralph E. Flanders, 319 pages, 5¼ x 8 inches. 219 illustrations. Published by John Wiley & Sons, New York. Price, $3.00.

The work gives a complete review of American and European gear cutting machines, and explains the theory of action. It is largely made up of the series of articles on gear cutting machines published in the engineering edition of MACHINERY, 1908, which treated the subject in the thorough manner that its importance deserves. Chapter I describes the methods of forming teeth of gears, and classifies gear cutting machinery accordingly. There are five recognized principles of action and four methods of operation. The formed tool, templet, odontographic, describing-generating and molding-generating principles are illustrated diagrammatically and simply described, and the impression, shaping or planing, milling and grinding methods are similarly treated, thus introducing the reader to the general subject with a full comprehension of the principles and action. The second and third chapters treat of machinery for cutting spur gears, the third chapter taking up in detail a subject that is attracting much attention at the present time, *i.e.*, the hobbing process. Chapter IV describes machinery for cutting the teeth of internal gears and racks. Machines for cutting the teeth of worms and helical gears are described in Chapter V, and worm-wheel cutting machines in Chapter VI. Machines for forming teeth of bevel gears are treated in Chapters VII and VIII. The work is the only complete treatment of gear cutting machinery published; it comprised every known commercial machine at the date of publication. It will be found of much interest and value to those concerned in the art of producing cut gearing.

CATALOGUES AND CIRCULARS

HOGGSON & PETTIS MFG. CO., New Haven, Conn. Catalogue of hand cut steel stamps for all purposes, also seal presses and cutting dies.

EMERSON ELECTRIC MFG. CO., St. Louis, Mo. Bulletin No. 3216 of bi-polar ventilated motors, ½ H.P. direct current.

E. J. BROOKS & Co., 227-229 Fulton St., New York. Circular of nailed box strap and seal and strap pulling device for sealing cases.

HESS-BRIGHT MFG. CO., Philadelphia, Pa. Sheet illustrating crane hook thrust ball bearing mounting equipped with Hess-Bright ball bearings.

WALTHAM MACHINE WORKS, Waltham, Mass. Circular on sub-press die work, illustrating samples of the work done and giving a brief treatise on sub-press dies.

MESTA MACHINE CO., Pittsburg, Pa. Circular of rubber mill machinery illustrating a three-roll calender and a 20 x 22 inch x 72 inch rubber grinder and mixer.

HOGGSON & PETTIS MFG. CO., New Haven, Conn. Pamphlet advertising engraved rolls, molds, cutting dies, rollers, gages, etc., for the manufacture of rubber goods.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Folder illustrating uses of lifting magnets in handling structural material, car axles, scrap, track bolts in kegs, railway rails, cylinder castings, etc.

HESS-BRIGHT MFG. CO., Philadelphia, Pa. Sheet illustrating drill press spindle with Hess-Bright thrust ball bearing mounting, showing two forms recommended.

WICKES BROS., Saginaw, Mich. Catalogue of plate working tools, comprising vertical and horizontal bending tools, punches, shears, riveting machines, flanging presses, annealing ovens, etc.

GOLDSCHMIDT THERMIT CO., 90 West St., New York. Pamphlets entitled "Metals and Alloys Free from Carbon Produced by the Thermit Process" and "Butt Welded Wrought Iron and Steel Pipe by the Thermit Process."

ARTHUR C. FRASER & USINA, 170 Broadway, New York. Bulletin of patent and trade-mark law, comprising the new copyright law, the trade-mark situation, an important patent decision and the revocation of patents in Great Britain.

LINK-BELT CO., Philadelphia, Pa. Bulletin No. 84 of "Maximum Silent Chain," illustrating its application to line shafting, machine tools, centrifugal pumps, blowers, air compressors, cylinder boring machines, mine fans, etc.

NATIONAL METAL TRADES ASSOCIATION, Robert Wuest, commissioner, 1005 Fourth National Bank Building, Cincinnati, Ohio. Synopsis of proceedings of the eleventh annual convention held April 14 and 15, 1909, Hotel Astor, New York.

SCHUCHARDT & SCHUTTE, 90 West St., New York. Catalogue of tachometers and tachographs. These instruments indicate on a dial or record on a chart the revolutions and rate of engine and motor shafts, the speed of fly-wheel peripheries, rate of travel of motor cars, etc.

PEERLESS AUTOMATIC MACHINE CO., Cleveland, Ohio. Leaflet illustrating the Peerless automatic multi-spindle screw machine having a capacity of 1 inch round, 15/16 inch octagon, 7/8 inch hexagon, and 11/16 square stock; length of work 5 inches. See July issue of MACHINERY for description.

BURROUGHS ADDING MACHINE CO., Detroit, Mich. Booklet entitled "A Better Day's Work," being a disquisition on accounting from the Stone Age down to the present, with particular reference to the value and use of mechanical adding machines for accurate and rapid work.

AMERICAN ENGINE CO., Bound Brook, N. J. Pamphlet treating of the balancing of reciprocating forces in steam engines, and illustrating the American-Ball angle compound engine, in which the high-pressure cylinder is horizontal and the low-pressure cylinder is vertical.

INTERNATIONAL-ACHESON GRAPHITE CO., Niagara Falls, N. Y. Circular on Acheson graphite, which is said to be the purest graphite made, being entirely a manufactured product. The circular lists electrodes, battery fillers, paint pigment, lead pencils, oil lubricants, ball bearing lubricants, etc.

INTERNATIONAL EXHIBITION OF RAILWAYS AND LAND TRANSPORTATION, Argentine Republic, Buenos Ayres. Circular No. 14, giving the aim and scope of the exhibition, statistics of the products of the Argentine Republic, railway mileage, organization of the exhibition, and names of the executive committee.

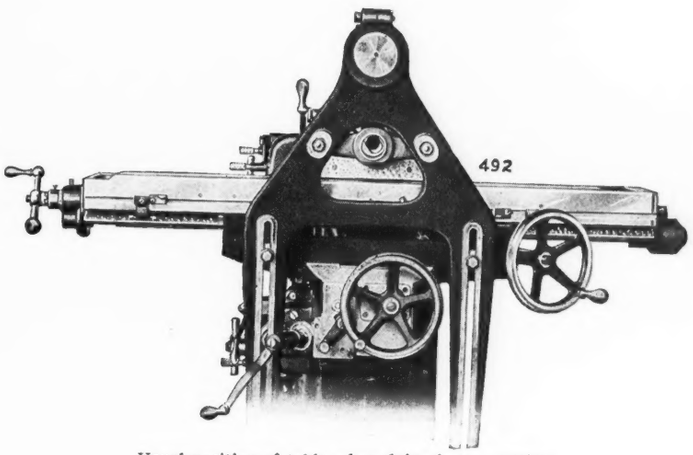
JOYCE-CRIDLAND CO., Dayton, Ohio. Bulletin No. 35 on automatic lever jacks. The construction of the automatic jack is described and illustrated, showing the various operations. It is claimed that these jacks have the power, simple action and closely graduated action obtained with hydraulic jacks without the complication and liability of failure.

MORSE CHAIN CO., Ithaca, N. Y. Bulletin No. 8, illustrating the application of Morse silent-running high-speed chains to line shafts, shapers, gear cutters, boring mills, engine lathes, punches and shears, rack cutting machines, grinding machines, screw machines, boring machines, blowers, bending rolls, milling machines, angle shears, forging machines, bolt threaders, etc.

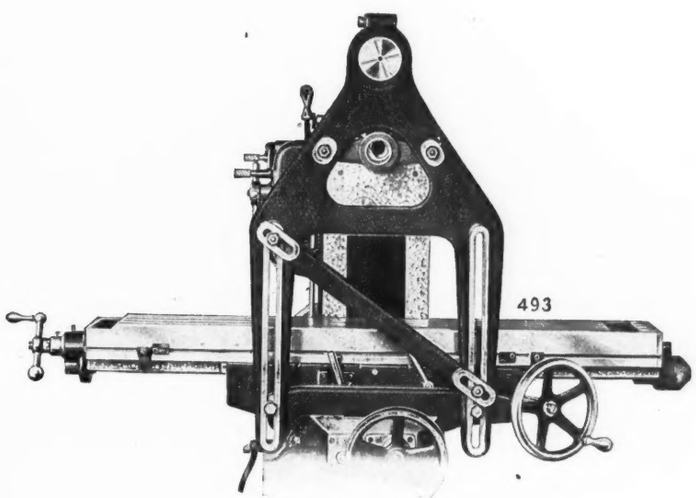
BUILDERS' IRON FOUNDRY, Povidence, R. I. Reprint from the journal of the American Society of Mechanical Engineers of the paper "A New Transmission Dynamometer" by Prof. W. H. Kenerson, Providence, R. I., which was presented before the Washington meeting, May, 1909, of the American Society of Mechanical Engineers. Copies will be sent free to all interested parties.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Booklet entitled "Electric Power for Domestic Purposes," which contains many suggestions for the use of small motors in the home. Among the many labor-saving applications of electric power are the sewing machine, vacuum cleaner, washing machine, ice-cream freezer, meat chopper, ironing machine, silver polisher, dish-washer, and pump.

CINCINNATI HIGH POWER ARBOR SUPPORTS



Usual position of table when doing heavy cutting



Unusual position of table.
Braces provided with an additional truss member

The importance of a rigid support for the outer arbor bearing is evident when we remember that this bearing gets as heavy pressures due to the cut, as does the main bearing of the machine.

The resultant of these pressures is approximately horizontal, in the direction of the table travel.

Our outer bearing support is designed to provide the greatest stiffness against this pressure.

It is made in one piece, truss form, bolted to its supporting member on the knee.

For work requiring the knee in a low position an additional diagonal brace makes it a double truss.

This is the principle on which bridges are designed.

It also applies in correct machine tool design.

WE HAVE APPLIED THIS PRINCIPLE IN EVERY IMPORTANT PART OF OUR HIGH POWER MILLERS.

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MILLING SPECIALISTS

CINCINNATI, OHIO

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
CANADIAN AGENT—H. W. Petrie, Ltd., Toronto, Montreal and Vancouver.
AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.

NEW HAVEN MFG. CO., New Haven, Conn. Catalogue of engine lathes from 18- to 65-inch swing, in all lengths of bed from 8 to 36 feet; planers, capacity 24 inches to 60 inches square and up to 20 feet length of stroke; and slotters of 10 inches stroke. The catalogue illustrates the construction of the New Haven lathe head-stock, tail-stock, quick change gear device, compound rest, double wall apron, etc., and will be found an interesting catalogue by those concerned with machine tool equipment and use.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Pamphlet entitled "Electric Motor Control," consisting of a series of five articles written by Mr. A. C. Eastwood, president of the company. The pamphlet treats of the importance of the controller, theory and application of rheostatic controllers, series parallel controllers, magnetic switch controllers and dynamic braking. The pamphlet is of general interest to all interested in the matter of electric motor control.

HOGGSON & PETTIS MFG. CO., New Haven, Conn. Catalogue 8C of the Sweetland lathe chucks, which are made in a large variety of sizes and styles. The catalogue lists three- and four-jaw combination chucks from 6 inches to 42 inches sizes; three- and four-jaw universal chucks in 4 inches to 42 inches sizes. Independent chucks are listed in sizes from 4½ inches to 36 inches, and geared scroll chucks from 2½ to 15 inches. The company also makes special chucks for all sorts of service.

VEEDER MFG. CO., Hartford, Conn. Circular on Veeder die castings, which are made of an alloy having strength of 15,000 pounds per square inch section in tension and 20,000 pounds in compression. These die castings are exact in form and dimensions. It is possible to produce castings within a limit of one-thousandth inch length or less, depending on the size. These castings are largely used on speed counters, cyclometers, coin counting machines, cash registers, typewriters, voting machines, telephones, and other apparatus made in large quantities.

CAREY MACHINERY & SUPPLY CO., 119-121 East Lombard St., Baltimore, Md. General catalogue, sixth edition, of machinery and supplies, comprising Corliss engines, horizontal and vertical steam boilers, hoisting engines, steam water heaters and purifiers, steam separators, boiler fittings, fire pumps, vacuum pumps, steam pumps, centrifugal pumps, geared pumps, engine lathes, pulley lathes, precision lathes, hand and bench lathes, shapers, planers, milling machines, screw machines, grinding machines, polishing lathes, wood-working machinery, wood trimmers, chucks, drills, taps, reamers, machinists' tools, etc.

ROCKWELL FURNACE CO., 46 Cortlandt St., New York. Catalogue illustrating various products of the company, comprising boiler flue heaters, heaters for skin drying molds for foundry purposes, furnaces for annealing gold, silver and bronze strips for coinage purposes, portable annealing, hardening and tempering furnaces, core ovens, apparatus for heating circular saws, semi-steel melting furnaces, rivet furnaces for structural work, annealing ovens, melting furnaces for brass and other alloys, regenerative furnaces for high temperatures, etc.

LONG & ALLSTATTER CO., Hamilton, Ohio. Catalogue No. 21 of punching and shearing machinery, comprising a great variety of sizes and styles for bridge, structural steel, railway car and other shops requiring machinery for punching or shearing of materials. The machines listed and illustrated comprise angle iron shears, bar iron shears, beam punching machines, bending and forming machines, boiler punches, cross-cut shears, deep throated machines, disk notching machines, disk punching machines, drop hammers, gate shears, horizontal punches, lever punches, lever shears, etc.

KEUFFEL & ESSER CO., Hoboken, N. J. Booklet describing the origin, growth and present scope of the Keuffel & Esser Co., manufacturer of drawing materials, mathematical instruments, surveying instruments, measuring tapes, etc. The booklet contains a reproduction of the first monthly rent receipt for $5.50, given in 1867, which is an indication of the humble origin of the present great business which now employs 900 people. Interspersed throughout the booklet are various illustrations of the factory buildings and the departments devoted to the manufacture of drawing materials, mathematical instruments, surveying instruments, and measuring instruments. Fourteen buildings are comprised in the plant, covering 237,000 square feet of floor space.

J. H. WILLIAMS & CO., 150 Hamilton Ave. and Richards St., Brooklyn, New York. Catalogue of iron, steel, copper, bronze and aluminum drop forgings. The catalogue has a beautiful cover showing an open end drop forged wrench in striking relief on a black cover. The catalogue lists a full line of wrenches, comprising single head and double head engineers' wrenches, single head and double head set-screw wrenches, box wrenches, double head tool post wrenches, straight handle and track wrenches, pin spanners, construction wrenches, etc., for all classes of users; drop forged lathe dogs, general service clamps, crank handles, tool-post fittings, thumb nuts, crane hooks, wire sockets, yoke ends, etc. The company's line of Vulcan drop forged chain pipe wrenches, special forgings for automobile work, etc., are also listed.

AMERICAN EXPOSITION, Berlin, 1910. Catalogue listing names of members of American advisory committee, German advisory committee and prominent business men interested in the exposition. The exposition is intended to show Europeans the excellence of American manufactured products and to strengthen existing relations between America and Germany. The management announces that the exposition will be unique in that the price of space per square foot will include the usual incidental expenses; it will cover suitable foundations for machinery, carpets, water, heat, light, and janitor service. The exhibitors will also be protected from loss by fire or theft by insurance to the extent of $25 per square foot. The rental including all extras is to be $4 per square foot. Exhibits will be held in the Exposition Palace, erected in 1907 at a cost of $1,500,000. It consists of two connected buildings of stone and steel construction and has a combined floor space of approximately 110,000 square feet.

JONES & LAMSON MACHINE CO., Springfield, Vt. Treatise entitled "Machine Building for Profit, and the Flat Turret Lathe." 252 pages, 6 x 9 inches. This publication touches on the economics of construction, principles of lathe design, turret lathe design, observation of running machines, views from various points, importance of adaptability, and contains extracts from "The Evolution of the Machine Shop," a work published by Mr. Hartness some years ago. The Hartness flat turret lathe is described in detail, its parts and the work produced being illustrated. The remarkable adaptability of the Hartness flat turret lathe to all classes of machine work is well illustrated by numerous halftone engravings. Diagrams follow, illustrating the operations on various classes of work and giving the dimensions and the time required. The treatise is unique and should claim the interested attention of every machine shop manager and foreman concerned with the economical production of manufactured products. A number of interesting hints will be found on machine shop management.

MANUFACTURERS NOTES

GOODELL-PRATT CO., Greenfield, Mass., has a new foundry in construction by the Aberthaw Construction Co., of Boston.

HOGGSON & PETTIS MFG. CO., New Haven, Conn., has moved its New York office from 107 Liberty St., to 103 Chambers St.

LINK-BELT CO., Philadelphia, Pa., announces that the Renold "silent" machinery driving belt, manufactured and sold by it, will hereafter be known as the "Maximum Silent Chain" (Renold type).

ROCKFORD MACHINE & SHUTTLE CO., Rockford, Ill., manufacturer of drill presses, milling machines, bench lathes, etc., has moved into its new factory, the improved facilities of which will largely increase its output.

AMERICAN PULLEY CO., 29th and Bristol Sts., Philadelphia, Pa., opened a store July 1 at 139 South Clinton St., Chicago, Ill., where a complete assortment of wrought steel belt and sash pulleys will be kept.

B. F. STURTEVANT CO., Hyde Park, Mass., reports that its fan and blower business has so increased that it was necessary to enlarge its plant to handle the increased business, and it intends to add still further to the plant next Spring.

RAY D. LILLIBRIDGE, technical publicity manager, has removed his office to 100 Broadway, eleventh floor, and has taken into partnership William L. Rickard. The business will be continued as heretofore under the name Ray D. Lillibridge.

THE NORTHWESTERN METAL MFG. CO., Minneapolis, Minn., has been appointed exclusive sales agent for the "plunger throttle plastic packing," which is a new packing material for locomotive throttle valve stems and similar purposes.

WHITMAN & BARNES MFG. CO., Akron, Ohio, has consolidated its offices at Akron, which is the headquarters of the company. Heretofore its business has been handled from several different points, and the change is made to give the trade better service.

CROCKER-WHEELER CO., Ampere, N. J., reports several orders received recently for large alternating current generators, one of which was for a 1,000 KVA, three-phase, 6,600 volt generator, for the De Laval Steam Turbine Co., Trenton, N. J.

CARLYLE JOHNSON MACHINE CO., formerly of Hartford, Conn., removed its business July 1 to Manchester, Conn., nine miles east of Hartford on the Willimantic division of the N. Y. N. H. & H. R. R., where its manufacturing facilities are much improved.

WELLS BROS. CO., Greenfield, Mass., invites all persons interested in the manufacture and use of screw cutting tools and machinery to visit its factory. It is suggested that vacationists make up their itineraries to include a visit to Greenfield and the company's works.

KEARNEY & TRECKER CO., Milwaukee, Wis., is building a new power plant in which an Allis-Chalmers Corliss engine is being installed. The company is otherwise making preparations to extend its machine equipment and plant generally to take care of the demands for the Milwaukee milling machines which are sold out far in advance.

BROWN & SHARPE MFG. CO., Providence, R. I., announces that its works will be closed from August 6 to 23 for the annual vacation and repairs. During the vacation the office will be open as usual and orders for machine tools, machinists' tools, and measuring tools will receive the same attention as at other periods of the year.

WESTERN ELECTRIC CO., 463 West St., New York, reports that for the first half of its fiscal year ending May 31 its business is running at the rate of approximately $46,000,000 yearly as compared with $33,000,000 for the fiscal year of 1908, and $53,000,000 for the fiscal year of 1907. Business thus has increased 40 per cent over 1908, and is 87 per cent of the 1907 record.

CROCKER-WHEELER CO., Ampere, N. J., directors held a meeting in July in the New York office of the company. Dr. Schuyler Skaats Wheeler was continued as president, and the other officers elected were: Gano Dunn, vice-president; A. S. Doremus, second vice-president; Gano Dunn, engineer; Rodman Gilder, secretary; W. L. Brownell, treasurer; G. W. Bower, assistant treasurer.

LINCOLN MOTOR WORKS CO., Cleveland, Ohio, has changed its corporate name to the Reliance Engineering & Electric Co., instead of the Reliance Engineering Co., as was erroneously stated in the July number. The management remains the same and the company will continue to manufacture the Lincoln variable speed motors and complete line of constant speed motors.

BROWN & SHARPE MFG. CO., Providence, R. I., is building a new power house, which will be a consolidation of the five separate power plants now in the works. The new power plant will have a capacity of about 3,000 horse-power, and will comprise up-to-date equipment such as Stirling water-tube boiler, Taylor gravity under-feed stokers, gas engines and producers, etc.

FOOS GAS ENGINE CO., Springfield, Ohio, reports that the United States Government recently placed an order for six Foos vertical gas engines to be used for the operation of locks on the Ohio River. The locks are worked by air, the engines being required for driving the air compressors, and are 100 horse-power each. The engines specified are the regular Foos vertical three-cylinder single-acting type, using natural gas as fuel.

CINCINNATI IRON & STEEL CO., Cincinnati, Ohio, has installed a 30-ton electric Case crane with the Cincinnati Traction Co., and has received an order for a 40-ton Case electric crane for the Nashville Railway & Light Co., Nashville, Tenn. The company also has an order for a 180,000 pound shear to cut six-inch square metal for the Goldberger Iron Co., Cincinnati, Ohio. The shear is being built by the Mesta Machine Co., Pittsburg, Pa.

INTERNATIONAL-ACHESON GRAPHITE CO., Niagara Falls, N. Y., received on the afternoon of July 2 a telegraphic order calling for a shipment by express of a carload of electrodes 8 x 48 inches. The shipment was immediately loaded on an express car, and at 7:30 P. M. the car was pulled out of the switch and delivered to the Michigan Central Railway, and early on Saturday, July 3, the electrodes were delivered to the consignee in Chicago.

WESTINGHOUSE MACHINE CO., Pittsburg, Pa., has made a contract with the Public Service Corporation of New Jersey for four 1,000-inch three-cylinder Westinghouse gas engines direct connected to Root positive blowers for their Hoboken and Passaic gas plants for the purpose of boosting the gas pressure in the mains. The engines are of the vertical type and develop 90 horse-power each, and use illuminating gas for fuel.

CUTLER-HAMMER MFG. CO. has purchased the plant, business and patents of the J. L. Schureman Co., of Chicago. The manufacture of the Schureman controller apparatus will be continued and Mr. S. M. McFedries, general manager of the Schureman Co., will remain in active charge of the manufacture of the Schureman apparatus. Mr. J. L. Schureman retires from business. Until further notice, customers of the Schureman Co. should direct orders or inquiries to the old address, J. L. Schureman Co., 70 West Jackson Boulevard, Chicago, Ill.

MCGRAW-HILL BOOK CO., 239 West 39th St., New York, is a consolidation effected July 1 of the book departments of the McGraw Publishing Co. and the Hill Publishing Co. The new company takes over the book departments of both houses with a list of about 250 titles, comprising industrial and college text-books and covering all lines of engineering. It will continue the retail, importing and jobbing business of the two houses. The officers are: President, J. A. Hill; vice-president, James H. McGraw; secretary, Edward Caldwell; treasurer, Martin Foss.

AMERICAN AIR COMPRESSOR WORKS, 26 Cortlandt St., New York, has engaged Mr. August Kittleberger, who for the past fifteen years has been associated with the Clayton Air Compressor Co., as superintendent of the American Air Compressor Works plant in Brooklyn, New York. The company regard the engagement of Mr. Kittleberger as an important addition to its manufacturing department, and with the

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REAMERS OR BROACHES

We have just imported an exceptionally large quantity of these Broaches in all sizes from No. 65 Stubs Drill Gauge to 21-64 in. diameter and are ready to make immediate shipment.

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NEW YORK, SINCE 1848

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revival of trade conditions and increased business resulting therefrom, looks for an enhanced popularity of the American Fairhurst air compressors and vacuum pumps.

PRATT & WHITNEY CO., Hartford, Conn., has been awarded a contract for equipping a small arms factory in Australia for the Australian government. The contract was obtained in competition with British manufacturers, the Pratt & Whitney bid being $340,000 as against 8500,000 by one British concern and the time of delivery one year as against three years required by a British concern. Minister of Defense Joseph Cook would willingly have been influenced to give the work to a British concern, but he was obliged to accept the American tender, as conditions all around were much better.

BUILDERS' IRON FOUNDRY, Providence, R. I., is making and marketing the Kenerson transmission dynamometer invented and patented by Prof. W. H. Kenerson, and illustrated and described by him in a paper read before the Washington meeting of the American Society of Mechanical Engineers, May, 1909. (See MACHINERY, June, 1909.) This dynamometer is a device which indicates by means of a pressure gage the amount of power transmitted through it. The dial on the gage is graduated to indicate H. P. per 100 revolutions per minute of the shaft to which the dynamometer is attached. In all probability it is the most sensitive and practical dynamometer designed for measuring transmitted power yet devised.

Technical Index, a comprehensive record of current technical literature published in Belgium, announces that hereafter it will be represented in the United States by the George H. Gibson Co., *Tribune* Building, New York City. The *Technical Index* appears monthly and gives a systematic descriptive record of original articles appearing in over 200 engineering and technical journals and reviews, also indexing the proceedings of technical societies and technical books issued in all countries. The method of indexing covers the name of the author, the title of the article in full, an explanatory note stating the contents of the article, the name and date of the publication in which the article appeared and the length of the article.

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If you take a tool of high grade steel driven by the great power in this Planer, and steadied by the solidity of this Arm, you can cut gear teeth fast.

The cost of keeping the planing tool sharp is small.

The spacing is accurate, because the crowding of a cutter between the teeth is avoided.

We would like to figure on Gears or Gear Planers for you.

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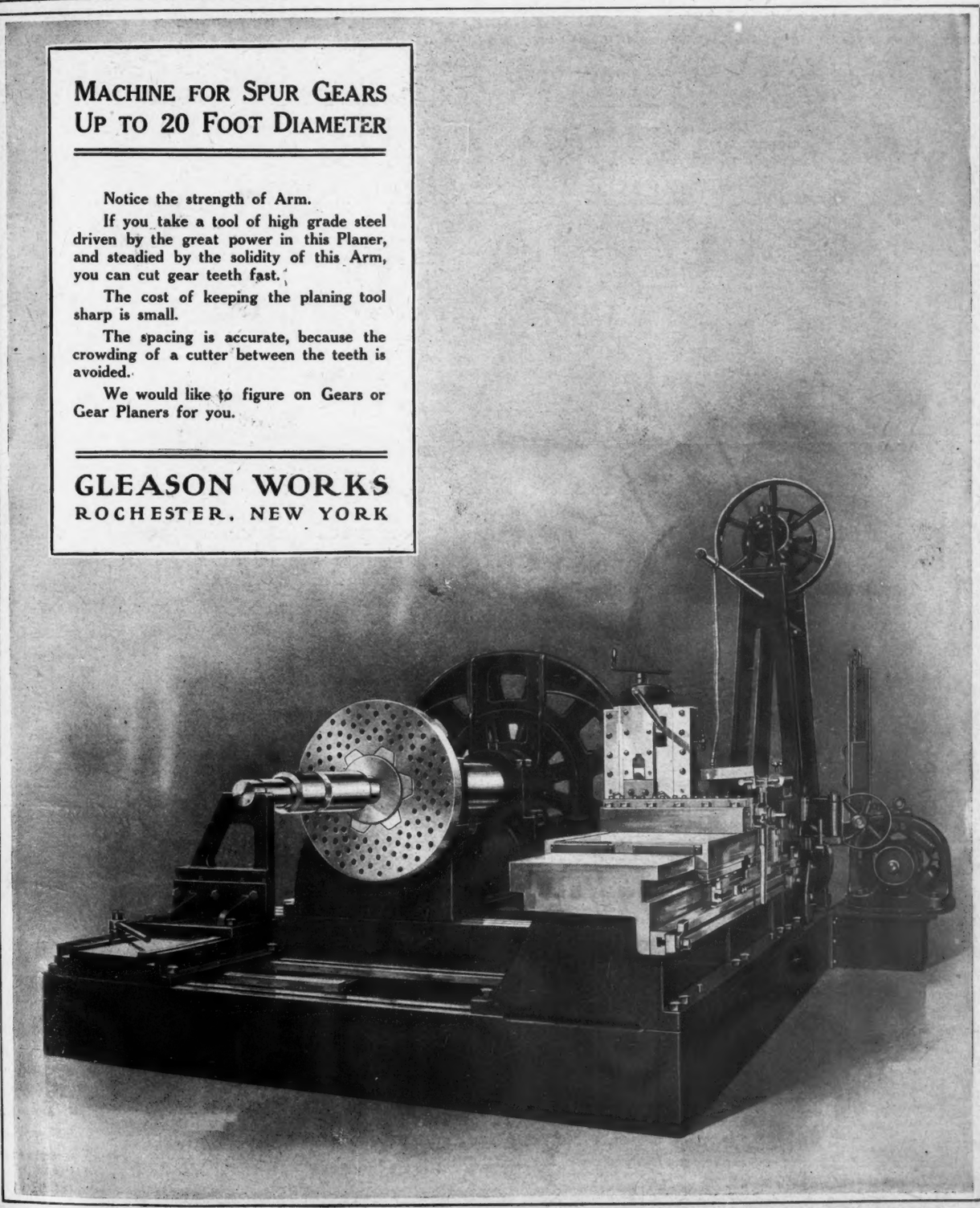

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Like all B. & C. Wrenches, is made to do its work right.
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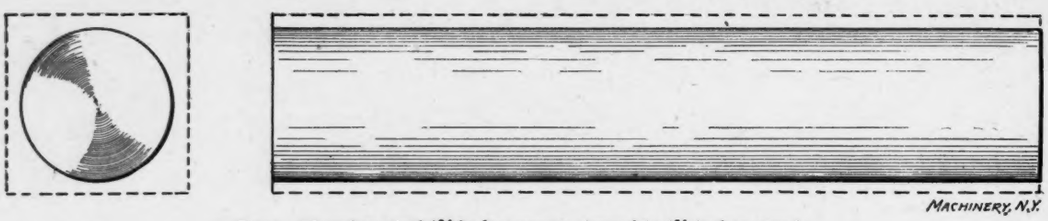

Piece—.50 carbon steel 1¾ inches square, turned to 1⅛ inches round.

At the start of this test the lathe was run at 550 revolutions per minute and a feed of 2½" per minute. Feed was then increased to 4¾" per minute, then to 5¾" and finally to 6⅝" per minute, at which point the superintendent of the plant stopped the work because he feared the lathe would not stand the strain—but the "Cyclone Special" High Speed Steel Tool showed no evidence of other than prime condition.

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will outwear cut gears and are an economy from every standpoint. They are entirely free from the defects of hand molded gears; are made from best material and are mechanically accurate. Teeth are of equal diameter at both ends, thus lessening the danger of breakage. They are uniform in size, true to pitch; require no machining, but are ready for use as soon as bored. Furnished in all forms—one inch circular pitch and upwards.
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WITHOUT THE ILLS
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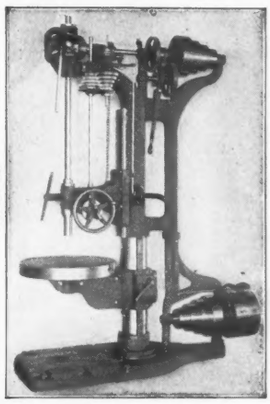

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Textile Feed Roll Fluting Planers. Frog and Crossing and Switch Point Planers. Locomotive Connecting Rod Planers 48"x17"x16". Duplex Planers, cutting a full stroke both ways 46" x 18" any length.

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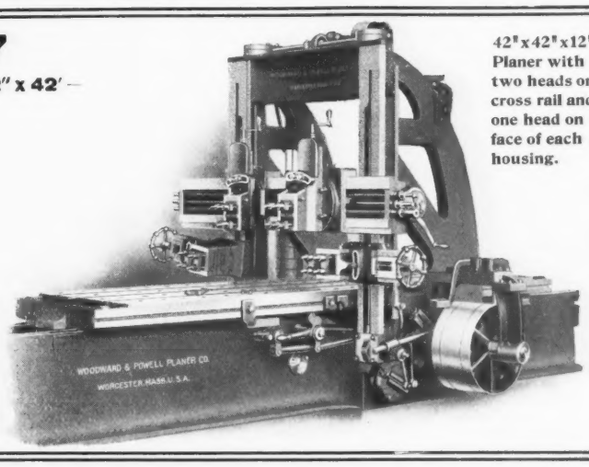
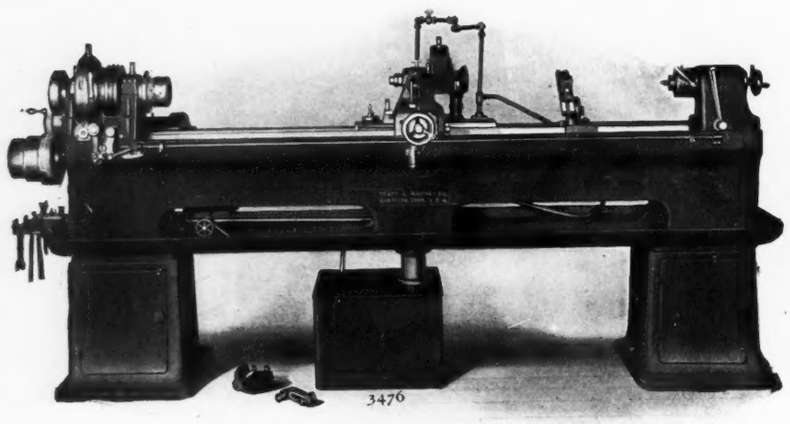


42"x42"x12' Planer with two heads on cross rail and one head on face of each housing.



6 x 80-inch Thread Milling Machine.

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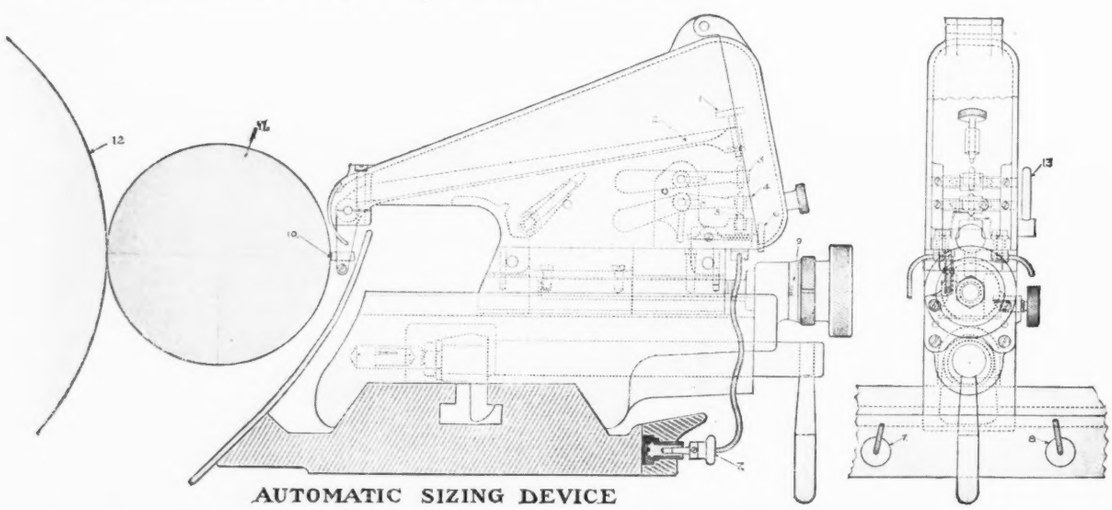
P. & W. THREAD MILLING MACHINES are built in six sizes.

Indispensable in shops where spiral gears, screws, worms, flexible shafts, etc., are manufactured.

Write for Catalog "Thread Milling Machines."

Milling threads is the modern way ensuring greatest accuracy as well as increased output.
Soft or hard spots in the stock are not torn or chipped.
For screws, spiral gears, worms, flexible shafts, etc., the lathe cannot compete in accuracy, finish or output.
Will mill from a straight line to a circle and any spiral between.
From two to six machines may be operated by one man.



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WHY WASTE TIME MEASURING?

when the P. & W. AUTOMATIC SIZING GRINDER will do it automatically and with greater accuracy than any man can do it.

In your shop—how much time is charged to grinding which actually is taken up by stopping your machines and measuring?

And how much work is spoiled by careless and uncertain measuring?

A boy can operate one to four of these machines and produce accurate work.

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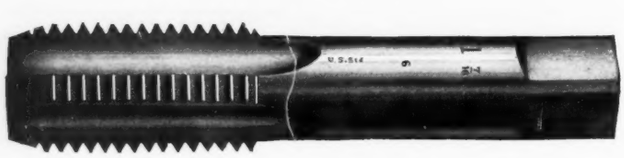

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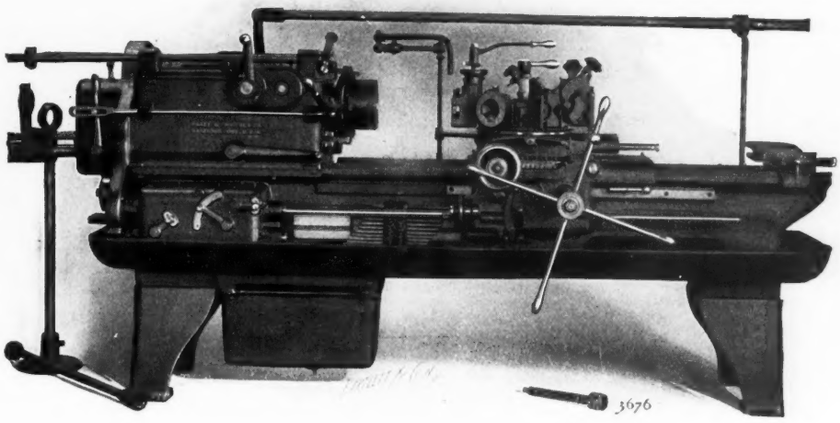

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Cross-Sliding Turret

combining great accuracy with the most powerful drive of all turret lathes of its size.

Sixteen changes of speed while running.

The Open Turret Lathe is equally suitable for work on bars, forgings, and castings.

Work is held in head-stock which is bolted solid to the bed and tool is brought to the work with a rigid, yet sensitive tool carrier.

Rod Chuck has extraordinary gripping power. Jaws are supported to extreme front end and have ⅛ in. adjustment for round, square or hexagon stock. All parts of chuck are hardened and ground.

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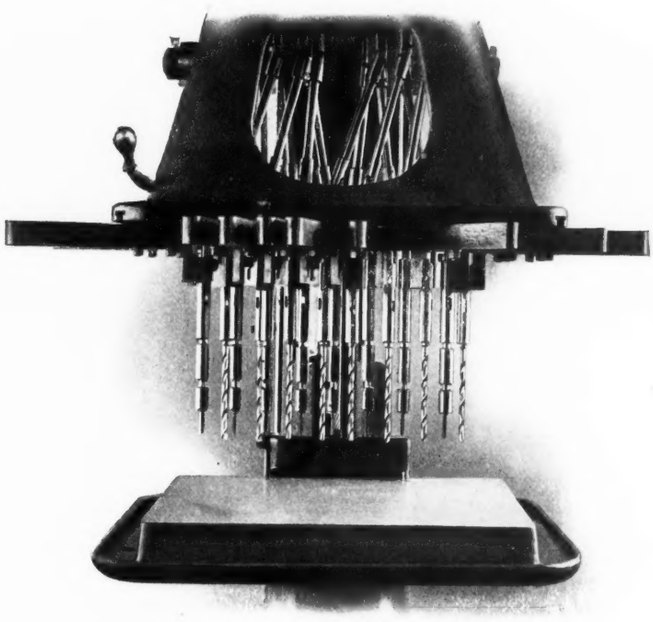

Multiple Spindle Drill arranged for Drilling and Tapping.

Drilling and Tapping

In addition to simultaneously drilling or counterboring a number of holes, the **P. & W. Multiple Drills** may be used to advantage in tapping threads. In such cases tap holders are furnished, which cause the taps to stop rotating when the required depth of thread has been cut.

Illustration shows machine with first row of spindles carrying eight drills and second row carrying eight taps which is an exceedingly economical method of performing such operations.

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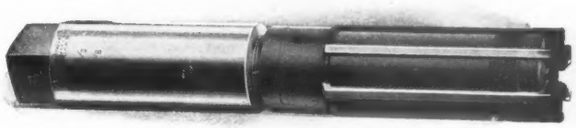
Reamers, Solid and Inserted Blade Milling Cutters, Punches, Taper Pins, Slitting Saws, Flue Beaders.

Tool Catalog.



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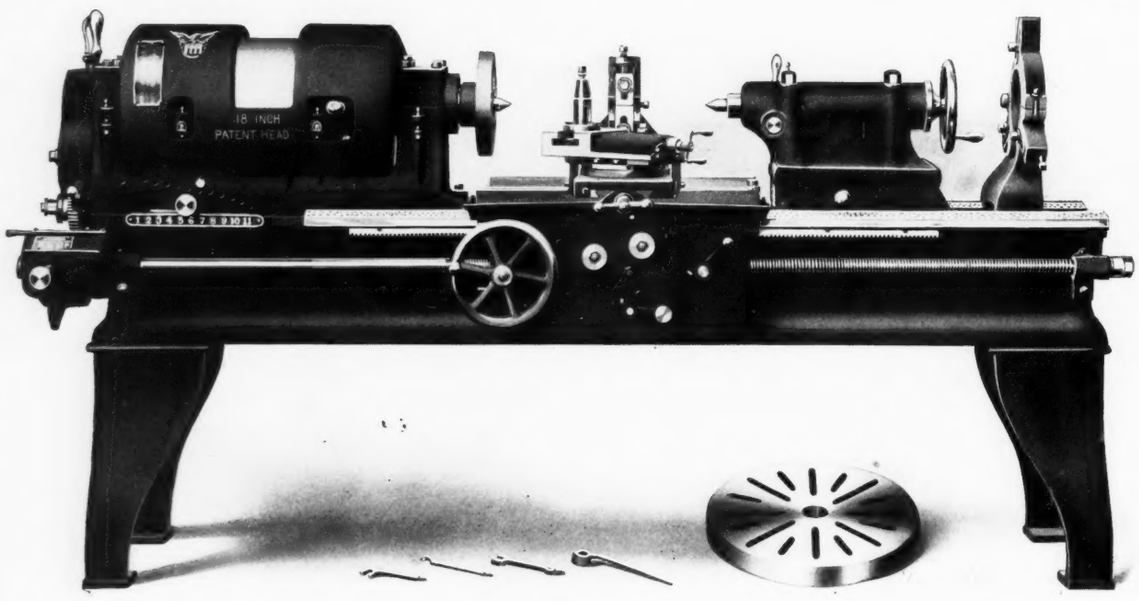
Permanent Lathe Accuracy



To insure exact work, a lathe should have:—

No belt pull on spindle, yet **open belt speeds** available for finishing.

Spindle long and rigid, with large journals positively oiled.

Bed heavy, deep and wide, stiffly braced internally.

Tailstock with long bearing upon bed; large spindle; solidity of tailstock barrel not impaired by long saw-cut.

Carriage top accurately planed; long bearings upon the V's.

Bridge unusually wide, giving large base for compound rest; scraped bearing against top and inside of bed, directly in line with tool thrust.

Apron strongly braced, and securely attached to carriage with both tongue and accurate cap screws.

Alignment of all parts made with great care, and lathe so designed that it will **stay accurate.**

All of these points are found in the "Patent Head" Lathe.
Our Catalog explains many other features good for your work.

The Lodge & Shipley Machine Tool Co.

CINCINNATI, OHIO, U. S. A.

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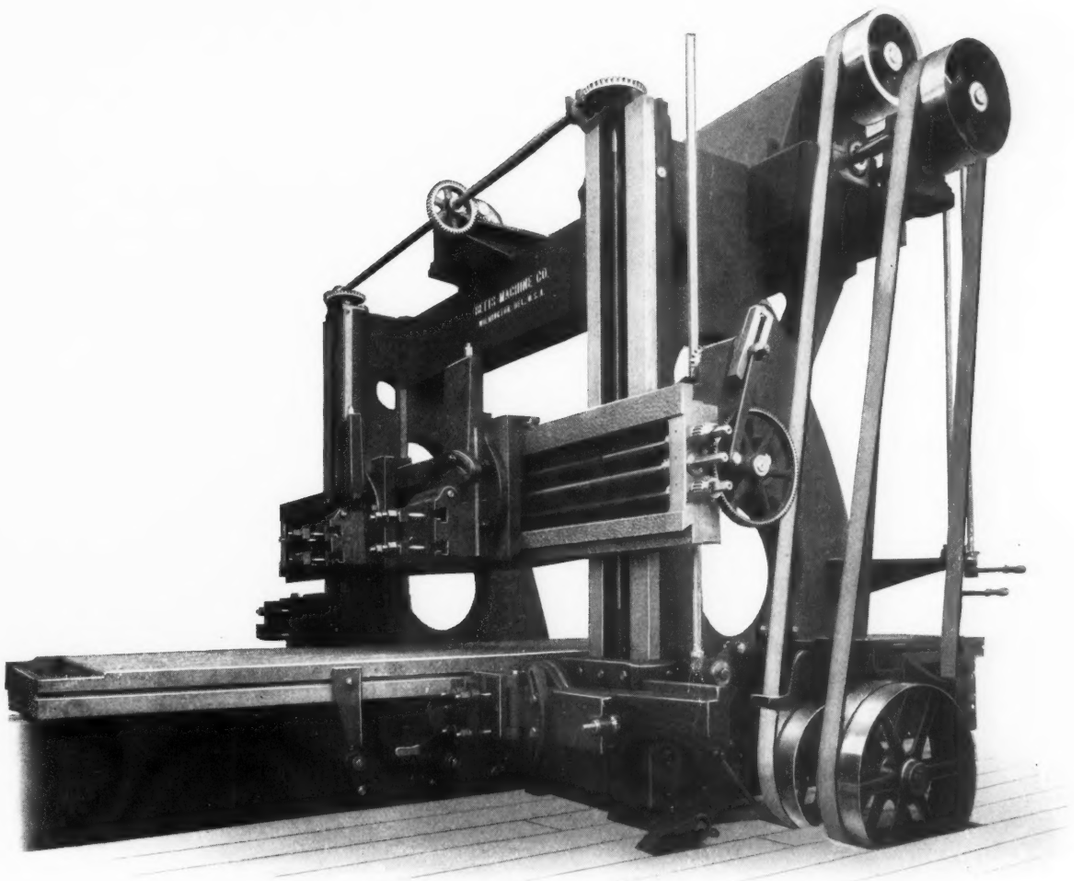
Makers of

Heavy Machine Tools

For High Speed Steel



The BETTS 120″ x 72″ Planer, as arranged with motor drive and variable speed gear box, for Erie Foundry Co., Erie, Pa. This machine, of course, has our well-known exclusive features—Extension Slide Side Heads, Crossrail Clamps on inside and outside of uprights, all STEEL GEARS, etc., etc.

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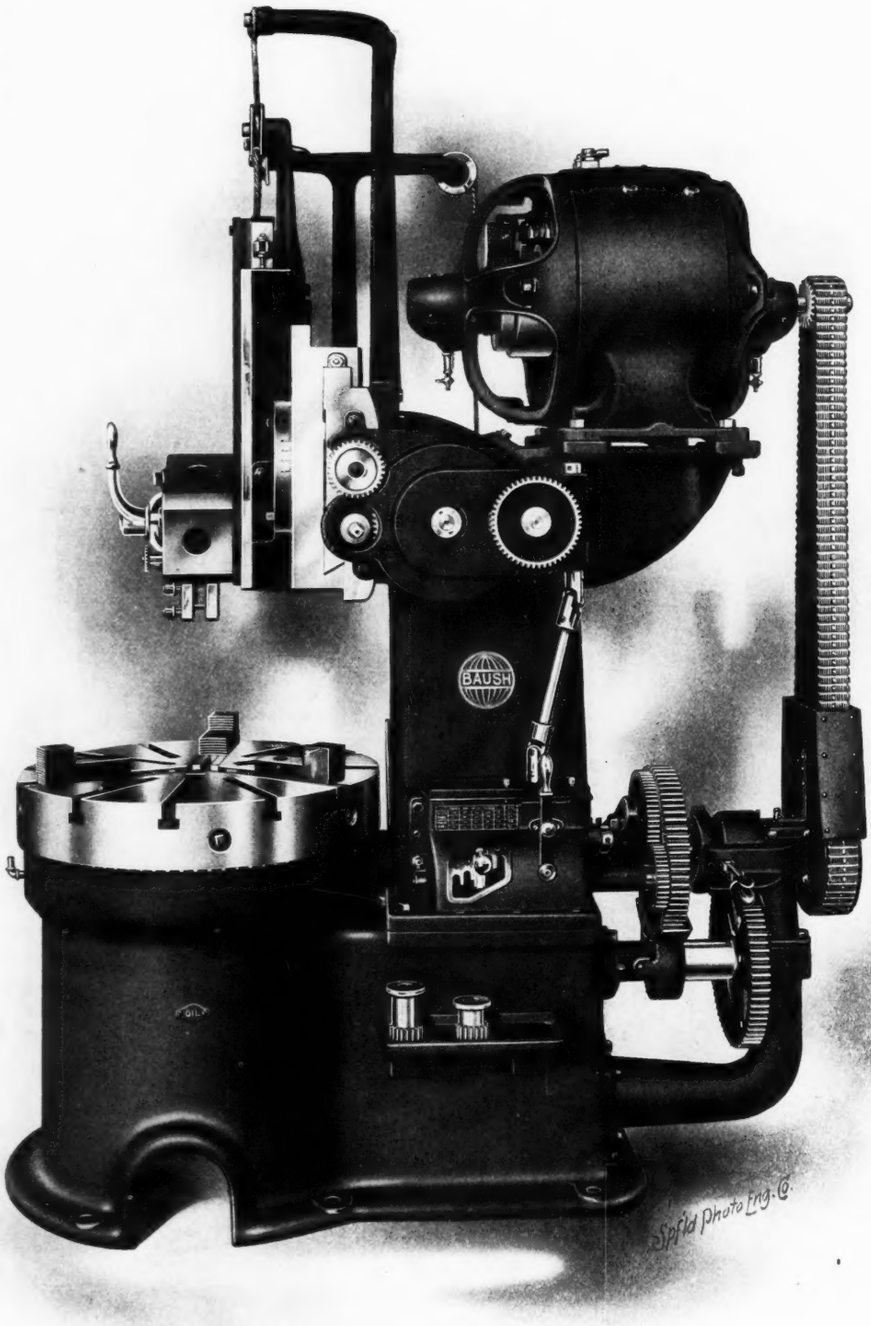

A Baush Boring Mill

is not only a work producer of the first order, but the accuracy of work can be absolutely depended on. The superior design, convenient fitting, and strong construction of these machines are trade standards, and the 30-inch Motor Driven Boring and Turning Mill, here shown, is a fair example of Baush efficiency. All improved features for easy and rapid handling, unusually broad table bearings with automatic oiling device, eight changes of table speed, change gear device for feeding and thread cutting. Belt driven if desired. We also build 37-inch, 42-inch, 51-inch and 61-inch sizes.

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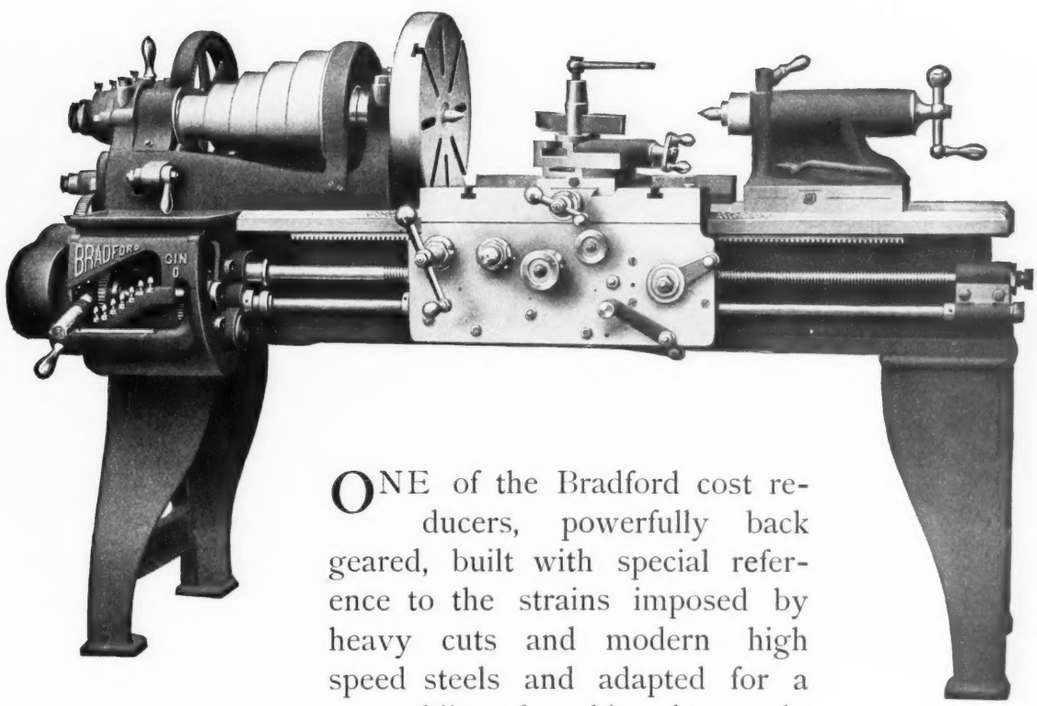
THE 16-INCH BRADFORD

A Quick Change Gear Lathe that is notable for its Range of Threads and Feeds, its Accuracy, Rapidity and general Convenience.



ONE of the Bradford cost reducers, powerfully back geared, built with special reference to the strains imposed by heavy cuts and modern high speed steels and adapted for a general line of machine shop work.

The range of threads and feeds is practically without limit for either right or left hand threads. Feeds for all standard threads, extra gears supplied for special threads if desired. Direct drive from spindle to lead screw or feed rod; cluster can be cut out entirely, driving screw direct with ordinary change gears. One lever for all threads. Accuracy of product from this lathe is assured by the accuracy of the machine itself.

Ask for Catalogue. Bradford Sizes 14 to 42 inch.

THE BRADFORD MACHINE TOOL COMPANY

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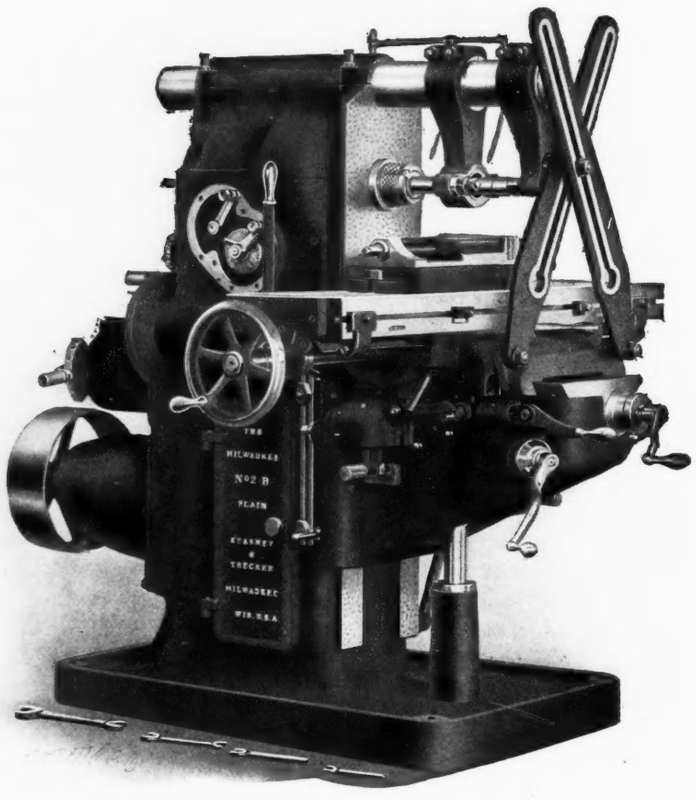

The Advantages and Conveniences of Milwaukee Milling Machines

stand out prominently. They are present day millers—heavy duty machines in every sense, and built to meet the most severe conditions. The very powerful drive is through a single pulley, without countershaft or overhead belts. All gears and bearings are automatically flooded with oil, and every machine is equipped with a pump for cooling and lubricating the cutters. The extra wide tables on both plain and universal machines will be found especially advantageous for clamping work. Electric drive easily applied at any time. Milwaukee Millers are quiet running, long lived, economical tools fitted with every improvement for rapid, safe and easy operation.

Full particulars sent on request.

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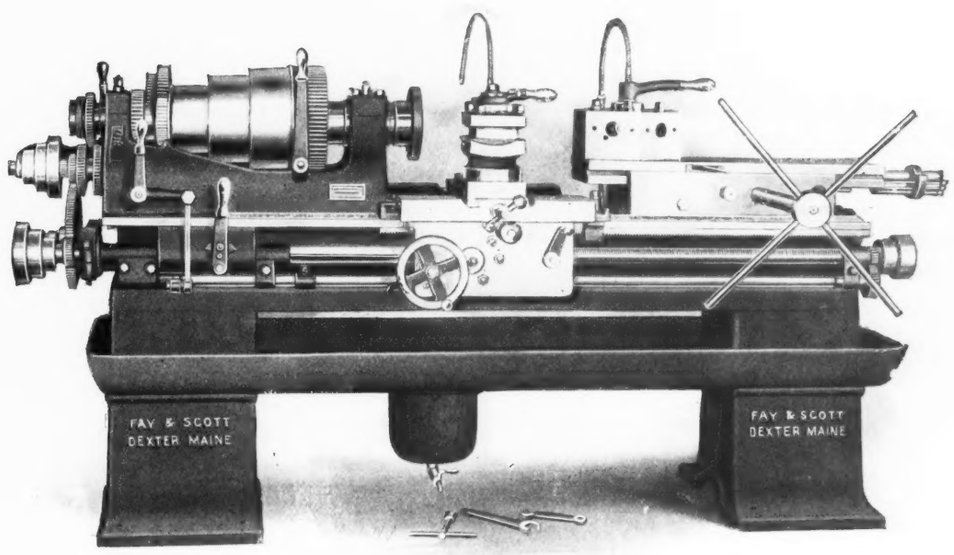
Rapid Production

THE PRENTISS LINE

Machine Tools

20-inch FAY & SCOTT

Universal Turret Lathe



The Fay & Scott Universal Lathe is especially designed for the manufacturing of duplicate parts from bar stock and castings.

If you are interested in increasing your output let us tell you how this machine will do twice the work of an ordinary engine lathe. It is regularly furnished with:

Double Friction Back Gears.
Automatic power feed to turret slide, and independent automatic stop for each tool.
Turret tool post by which any of four tools can be immediately brought into position.
Automatic stop for carriage feed.
Taper turning attachment and automatic adjustable collet attachment can be furnished if desired.

Prompt Deliveries. **Full information on request.**

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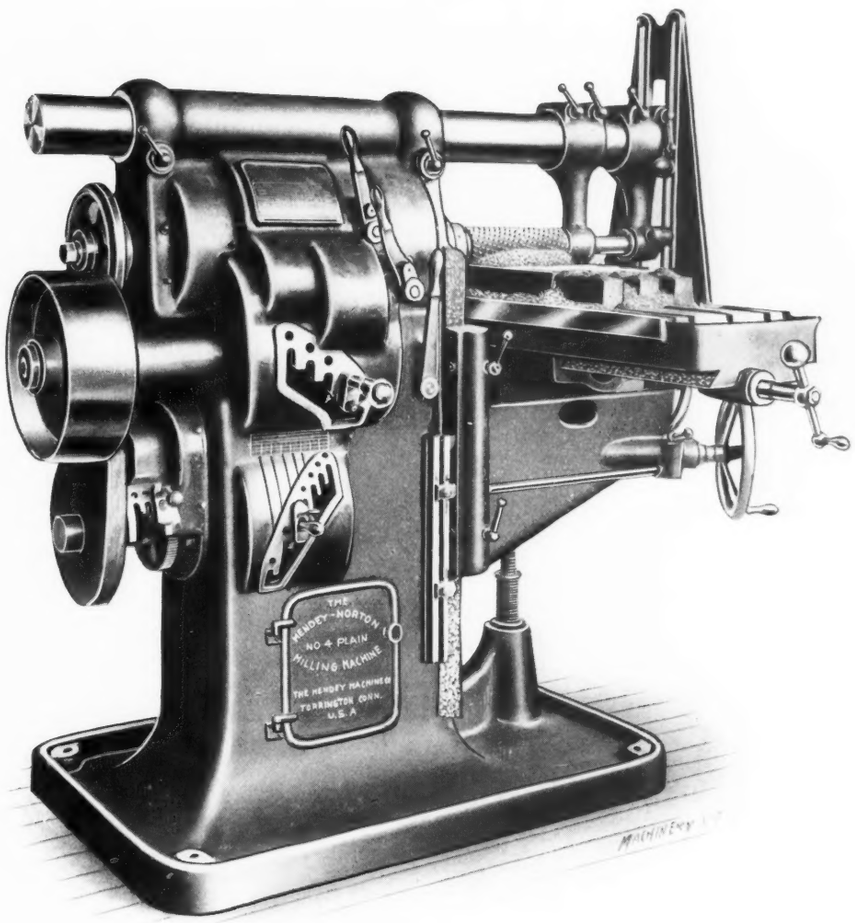


Hendey No. 4 Geared Spindle Miller

Attention is particularly invited to the plain and easily comprehended operating features of this milling machine. The familiarity of thousands of mechanics with our lathes enables them to tell at a glance that the arrangement of gearing for feed changes and spindle speeds is practically the same as the system they have been accustomed to in our lathes, which is generally acknowledged the best and most efficient gear change device. Of the three levers shown toward the front of column, the two upper operate positive toothed clutches, one on the back gear shaft and one on the main spindle. The third forward lever operates expanding ring clutch in the driving pulley on power shaft, this stopping and starting feature admitting of machine being run from main line if preferred.

There are fifteen mechanical speed changes to spindle, five in the gear cone, ten through the double back gearing.

Dimensions of main spindle bearing 4¼″ to 3⅜″ taper diameter, 6½″ long, Bearings ring oiling.

Working surface of table 60″ x 16″. Feeds 42″ x 12″ x 20″, all automatic. 21 feed changes.

Feed clutches and reversing lever all within easy control from front of machine.

This miller, in common with our other sizes, employs the projected knee bearing on column, introduced in knee construction by us, having been developed in our shaper cross heads several years ago.

Safety trips for all feeds. Ball bearing thrusts on table feed and elevating screws.

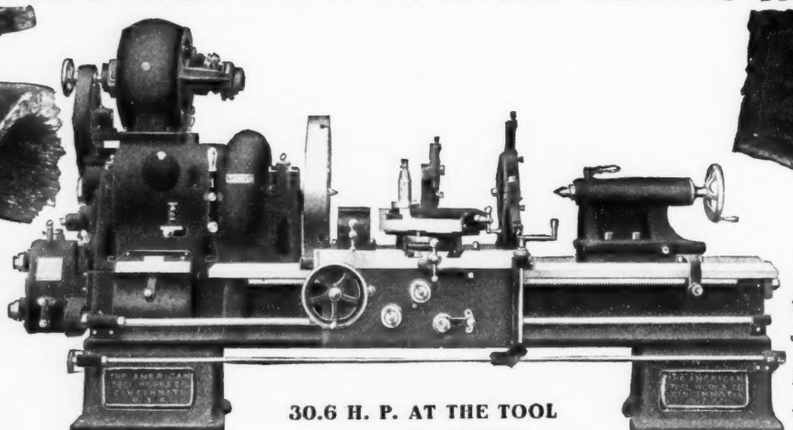
The roughing cut shown on table of machine is a matter of 18 cubic inches of metal removed per minute. Cutter face 12″, material grey cast iron. Well within the ultimate limit of power developed in the machine.

The Hendey Machine Co., Torrington, Conn., U.S.A.

AGAIN, ACTUAL FACTS

LIFE SIZE

CHIPS
FROM
24" "AMERICAN" LATHE
MOTOR DRIVEN THRU "PATENTED" GEARED HEAD



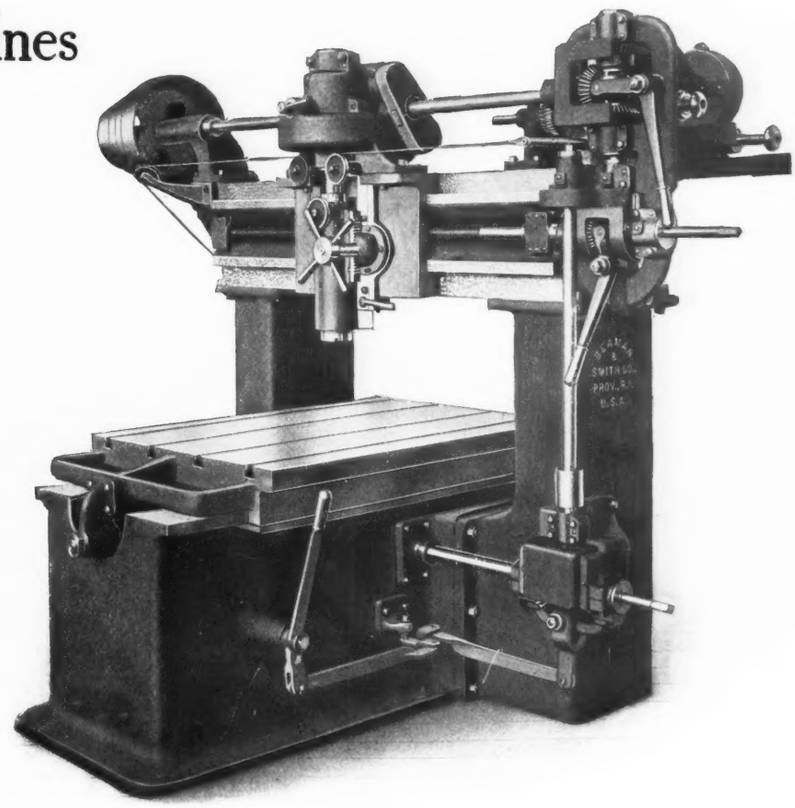
30.6 H. P. AT THE TOOL
75 FT. PER MINUTE
624 LBS. REMOVED PER HOUR
STOCK—TOUGH MACHINERY STEEL

THINK IT OVER

OUR GEARED HEAD LATHES ARE ENDOWED WITH
ENORMOUS POWER
ARE BUILT FOR JUST SUCH SERVICE

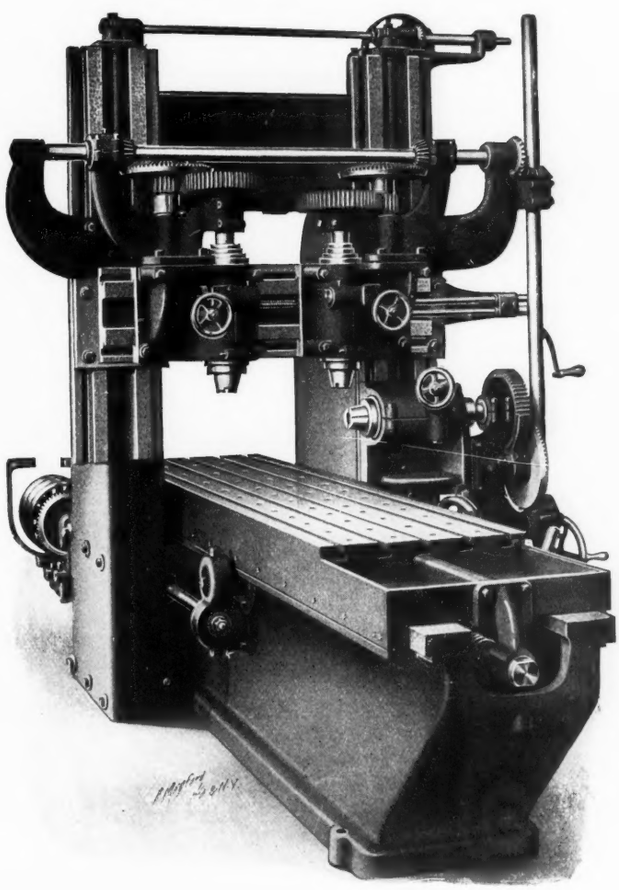
THE AMERICAN TOOL WORKS CO.
CINCINNATI, O. U.S.A.

Milling Machines That Meet Special Requirements



Quick Operating Vertical Spindle Milling Machine

Conveniently controlled. Power quick movements and feeds in either direction of work table and spindle saddle. Table 36″ wide, 48″ long.



Three Spindle Milling Machine No. 1—

A convenient machine having one horizontal and two vertical spindles. Work surface of table is 8′ x 24″, with quick power movement in either direction.

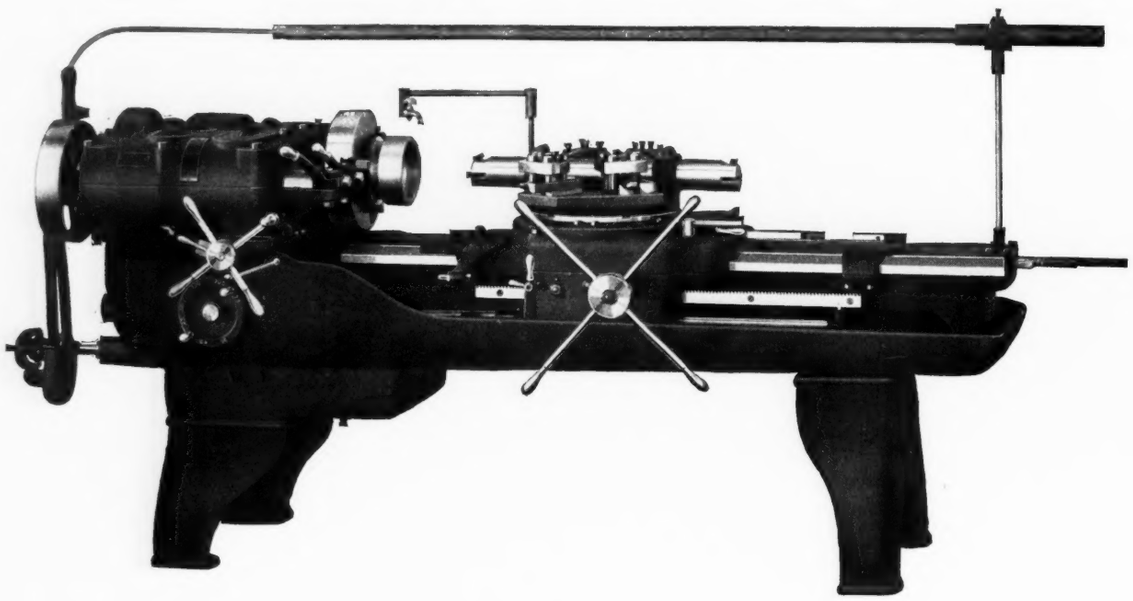
Send for Catalogue showing full line.

The Beaman & Smith Co.

Providence, R. I., U. S. A.

AGENTS—Chas. Churchill & Co., London. Ludw. Loewe & Co., Berlin. Fenwick Freres & Co., Paris.

SUMMING UP FOR THE



If you have reached the point where you are convinced that it is the "adaptable" turret lathe, hand operated, that you want in order to get out any piece any time, and get it out in large or small lots—(yet you are bewildered by the claims made for the "just as good" machines which are out of our business)—let us give you a few pointers which will make it possible for you to settle the question in your own mind, without the unsettling advice of our friends, the enemy.

If you cannot see a sample of each machine running, (and by the the way the other machines are hard to find) then take the cut of each machine—see how readily you can pick out the original machine, the one that was designed on the natural lines, and then see the others, that were compelled to take the next best way.

The original accomplishes its ends by the simplest and most direct means.

It has the fewest levers; it uses the most substantial tools with the

QUEEN VICTORIA ST.
LONDON, ENGLAND

JONES & LAMSON

Germany, Holland, Belgium, Switzerland, Austria-Hungary, M. Koyemann, Charlottenstrasse, 112 Dusseldorf, Germany.

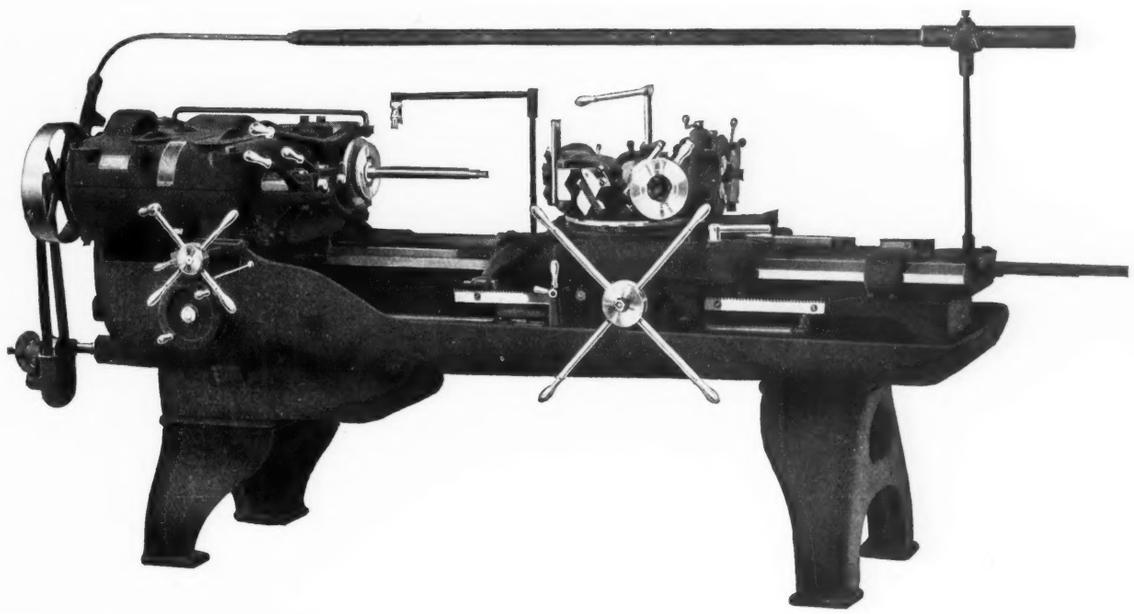
FLAT TURRET LATHE

least overhang of work or tools; it has business lines, and not fussy accumulation of parts; it is not built on the frail slide upon slide scheme of design; its stops are where they will most accurately arrest the cutting tool, not the lowermost corner of carriage apron (down in "Chipville").

After looking at the cuts, read the book sent free, "The Hartness Flat Turret Lathe." It tells of a machine that has had the benefit of not only the first choice of means to the ends desired, but also a thousand and one minor but important developments of details that come only by continuous application and exclusive devotion to just one thing, by the entire force and organization of a Company.

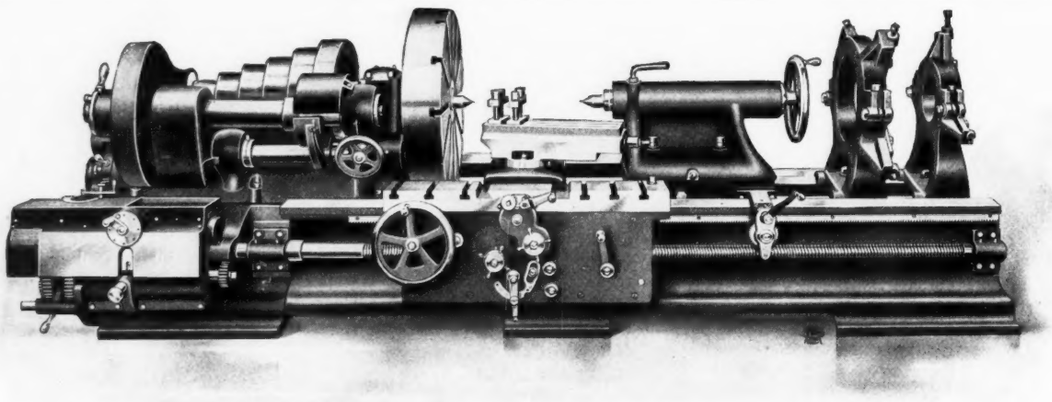
Don't forget the importance of each workman in our plant knowing by experience how to make the best machine.

The book tells all this and more—get it and read it—your success depends on your moves.



MACHINE COMPANY, SPRINGFIELD, VERMONT, U. S. A.

France and Spain, Ph. Bonvillain and E. Ronceray, 9 and 11 Rue des Envierges, Paris. Italy, Adler & Eisenschitz, Milan.



THIRTY-SIX INCH TRIPLE GEARED
INSTANTANEOUS CHANGE GEAR
ENGINE LATHE

WITH DOUBLE PLATE APRON.

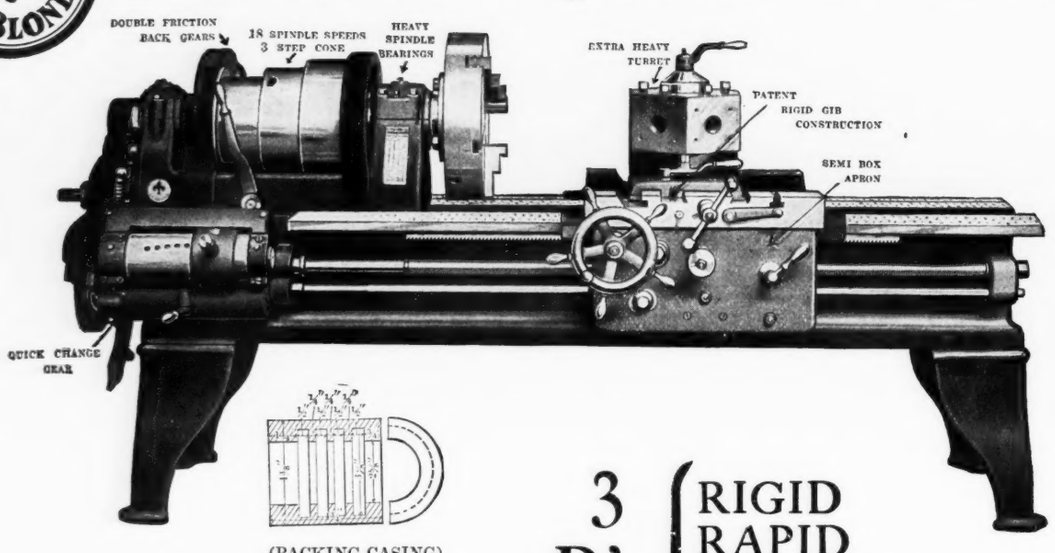
SCHUMACHER & BOYE

Engine Lathes, 18" to 48" Swing **CINCINNATI, OHIO, U. S. A.**

DOMESTIC AGENTS—Manning, Maxwell & Moore, New York City, Chicago, Boston, Syracuse, St. Louis, Atlanta, Philadelphia. The Baird Machinery Co., Pittsburg, Pa. The Strong, Carlisle & Hammond Co., Cleveland, Ohio, and Detroit, Mich. Henshaw, Bulkley & Co., San Francisco, Cal. The Pacific Coast Mfg. Co., Los Angeles, Cal. The Perine Machinery Co., Seattle, Wash. F. W. Cook, Spokane, Wash. Kellogg & Co., Toronto, Ont.

LE BLOND

LE BLOND 20" Special Turret Lathe



(PACKING CASING)

Bored, Faced and
Four Slots turned on inside
Time—15 Minutes

3 R's { RIGID RAPID RELIABLE

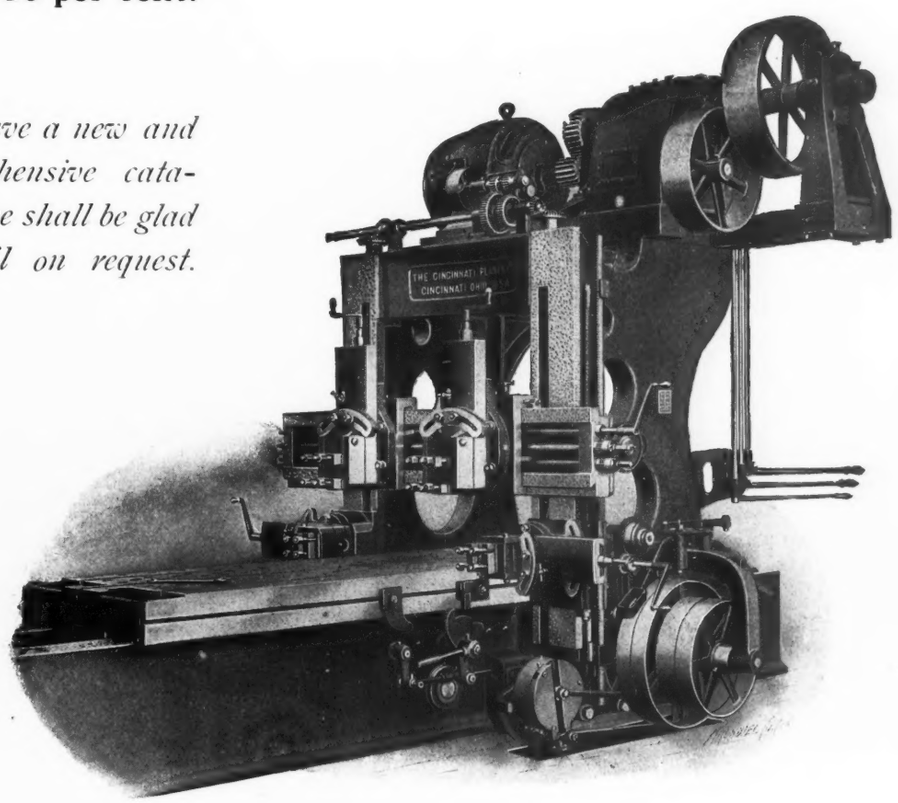
The R. K. LeBlond Machine Tool Co., **4609 Eastern Ave., CINCINNATI, OHIO.**

The Economy of the Cincinnati Variable Speed Planer is one of the big things about it.

WITH a range of speeds varying from 15 feet to 50 feet per minute, there is no excuse for wasteful or improper speeds. Roughing or finishing cuts can be taken, steel or brass, soft or hard castings can be planed, at the exact and profitable speed. Any speed within the range is easily obtained and return of table is always the same.

The Cincinnati Variable Speed Planers are strong and rigid in construction, will stand continued service of the hardest kind, take the heaviest cuts without balk or tremor, are power savers and will **increase production 25 to 50 per cent.**

We have a new and comprehensive catalogue we shall be glad to mail on request.



42" Variable Speed Forge Planer with Motor Drive

THE CINCINNATI PLANER CO., Cincinnati, O., U.S.A.

DOMESTIC AGENTS—Prentiss Tool & Supply Co., New York, Syracuse, Boston and Buffalo. Marshall & Huschart Mchy. Co., Chicago, St. Louis and Indianapolis. Motch & Merryweather Mchy. Co., Cleveland, Cincinnati and Detroit. W. E. Shipley Mchy. Co., Philadelphia, Pa. Baird Mchy. Co., Pittsburg, Pa. Scott Supply and Tool Co., Denver, Col. Harron, Rickard & McCone, San Francisco and Los Angeles, Cal. Hallidie Mchy. Co., Seattle. Robinson, Cary & Sands Co., St. Paul. Zimmerman, Wells, Brown Co., Portland, Oregon. Utah Mining Mchy. & Supply Co., Salt Lake City. M. E. Dewstoe, Birmingham, Ala. Morrison Mchy. & Supply Co., Richmond, Va.

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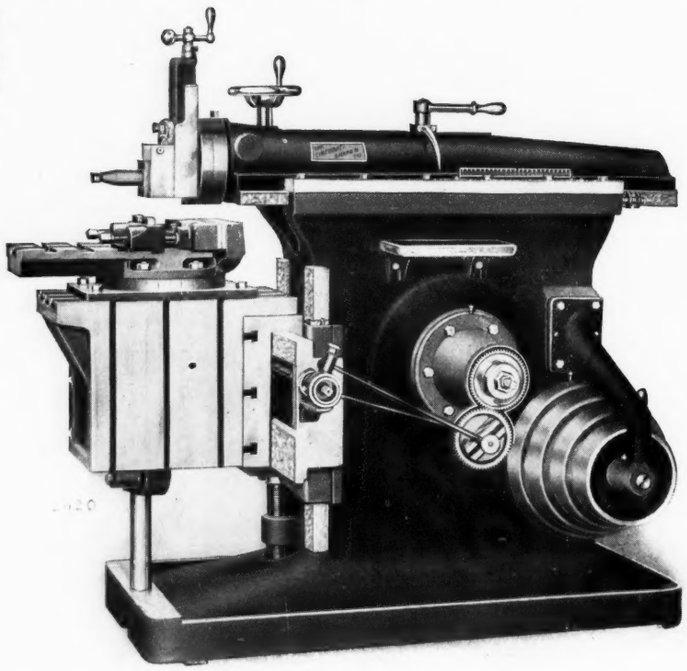
Cincinnati Heavy Duty Shapers

The most powerful shapers of their stroke on the market; redesigned to meet the severe requirements of modern work.



The universal use of high speed steels has made power, rigidity, unusual strength and rapid operation essential features of an up-to-date machine tool, and these points are amply covered in "Cincinnati" Shapers. Not only adapted for the heaviest classes of work, but also possess accuracy for the finest grades of manufacture.

Send for Catalogue "F".

The Cincinnati Shaper Co.

CINCINNATI, OHIO, U. S. A.

AGENTS—Manning, Maxwell & Moore, Inc., New York, Philadelphia, Chicago, Boston, St. Louis, Syracuse, Birmingham, Detroit, Milwaukee, Mexico City and Tokio. Brown & Zortman Machinery Co., Pittsburg. The National Supply Co., Toledo, O. Bailey-Smith Machinery Co., San Francisco, Cal. Smith, Booth, Usher Co., Los Angeles, Cal. Hallidie Machinery Co., Seattle, Wash. Zimmerman, Wells, Brown & Co., Portland, Oregon. C. T. Patterson Co., Ltd., New Orleans, La. A. Warden & Co., London, E. C. A. H. Schutte, Brussels, Cologne, Bilbao, Paris, Liege, Milan. Schuchardt & Schutte, St. Petersburg, Vienna, Budapest, Berlin, Copenhagen, Stockholm. H. W. Petrie, Ltd., Toronto, Montreal and Vancouver. Thos. McPherson & Son, Melbourne.

Accurate Spur Gears

THE CINCINNATI AUTOMATIC GEAR CUTTING MACHINE

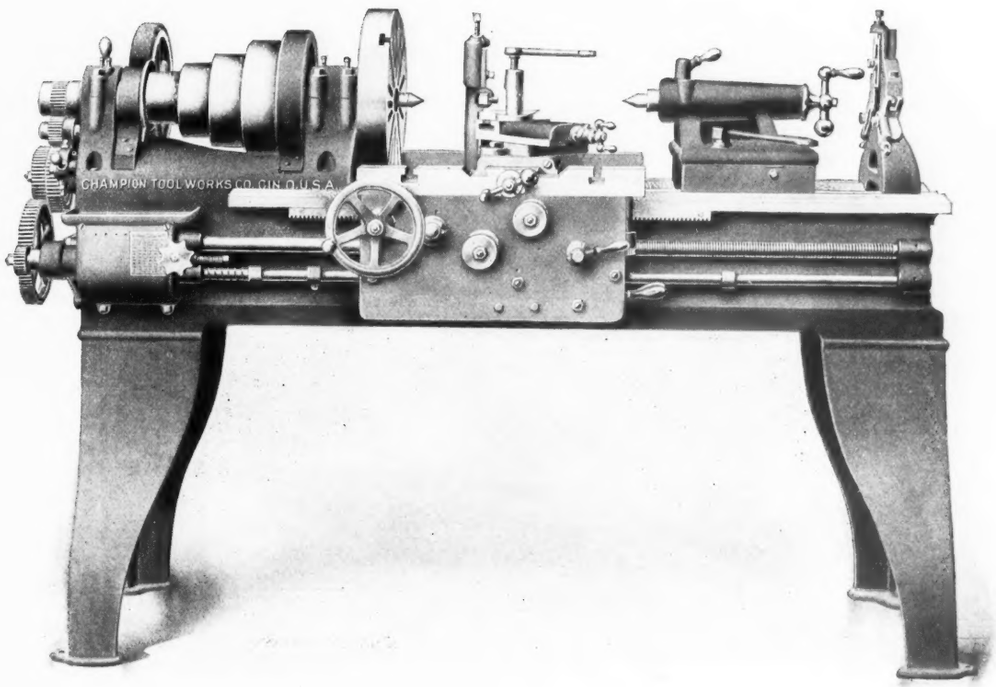
designed for the accurate and economical production of spur gears, is simple, compact and rigid, built along the most approved lines and has special features facilitating easy adjustments and rapid operation. The drive is through a single pulley running at constant speed; feed and speed changes, as well as indexing, obtained by change gears. A high grade machine in every particular.

Ask us for full details.

The Cincinnati Gear Cutting Machine Co.

CINCINNATI, OHIO, U. S. A.

Manning, Maxwell and Moore, Inc., New York, Boston, Chicago, Philadelphia, Pittsburgh, St Louis, Cleveland, Syracuse, Atlanta, Buffalo, Mexico City, Milwaukee and Detroit, Agents.



THE NEW STANDARD 16-INCH "CHAMPION" ENGINE LATHE

The very day you put it in active operation you'll notice a difference in the ease, rapidity, economy and accuracy with which your work is handled. For the "Champion" is abreast of the times. It realizes all present-day requirements and anticipates future ones. Consequently it's better able to handle ALL propositions that come its way than any other lathe on the market.

We have increased the proportions, thus insuring added weight and rigidity throughout. And countless exacting tests under severe conditions have proven beyond all doubt its remarkable power, efficiency and economy.

JUST A FEW EXTRACTS FROM OUR CIRCULAR

1⅝ in. Hole through Spindle.
Bronze Bearings.
Front Bearing Spindle 2⅝ in. dia., 4¾ in. long.
Carriage 22 in. long.
Swings 17⅛ in. over bed.
16 spindle speeds.
3 in. belt.

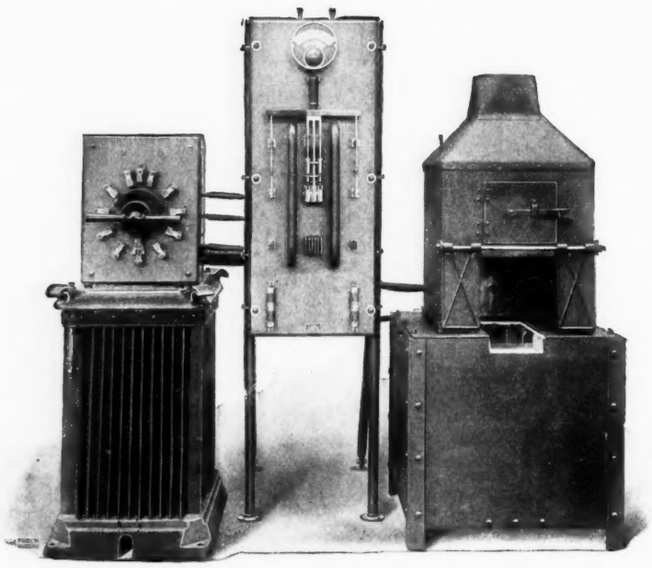
Cuts screw from 2 to 96 per in.
Has Chasing Dial; no occasion to reverse countershaft.
All gear feeds, reverse from apron, rapid changes, and Automatic Stop in either direction.

LATHES FOR MODERN CONDITIONS, 10, 12, 14, 16 AND 18-INCH SWING

Our Circular explains other valuable features that will interest you.

CHAMPION TOOL WORKS COMPANY

2422 SPRING GROVE AVENUE, CINCINNATI, OHIO, U. S. A.



AN ELECTRIC FURNACE

For Hardening Low Carbon and High Speed Steels

Suitable for the treatment of steel tools, dies, files, cutlery, etc.

The temperature can be controlled with absolute precision by regulating the amount of current passing through the bath.

The temperature, once adjusted, remains constant without attention.

The material treated is heated uniformly all through without any burning of sharp edges or points.

The operator can ascertain the exact temperature of the material. No oxidation, as the material is not exposed to the air.

Low cost of upkeep. Expert attention not required. Practical tests show that this furnace is quicker and cheaper in operation and gives better and more uniform results than any form of gas or coal furnace. Can be readily installed on any alternating current system. Outfit includes all necessary controlling and transforming apparatus.

Described in Bulletin 441-C.

General Electric Company

Principal Office: SCHENECTADY, N. Y. **Sales Offices in all Large Cities.**

2148

NEWTON

(REGISTERED TRADE MARK)

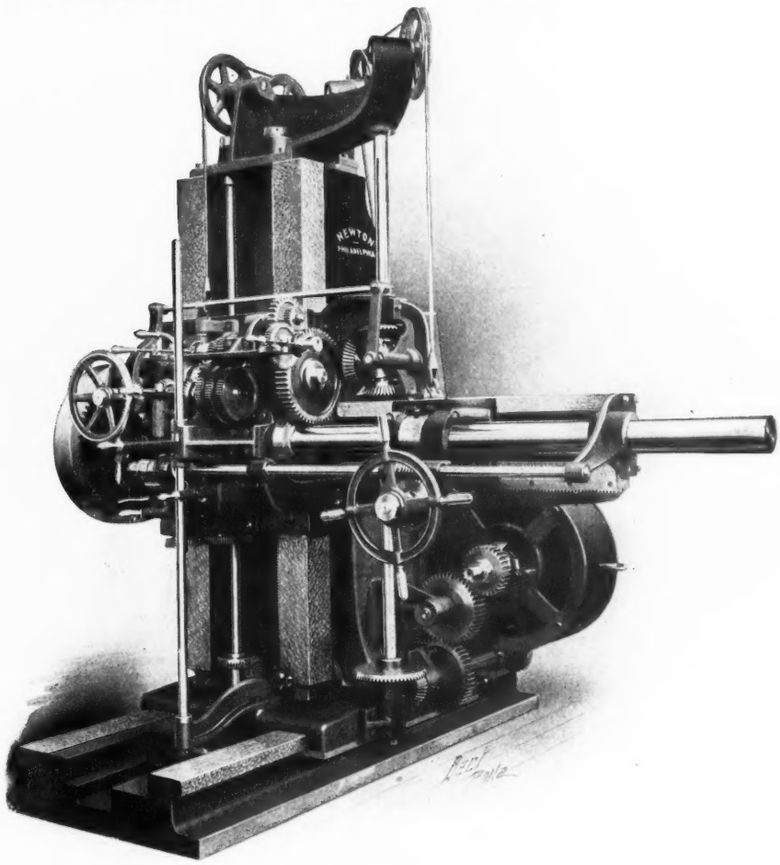
Exhibits in spaces 133 and — at Atlantic City during M. M. and M. C. B. Convention

Rail Ending Machines

Rail Drilling Machines

Rail Sawing Machines

Arch-bar Drilling Machines



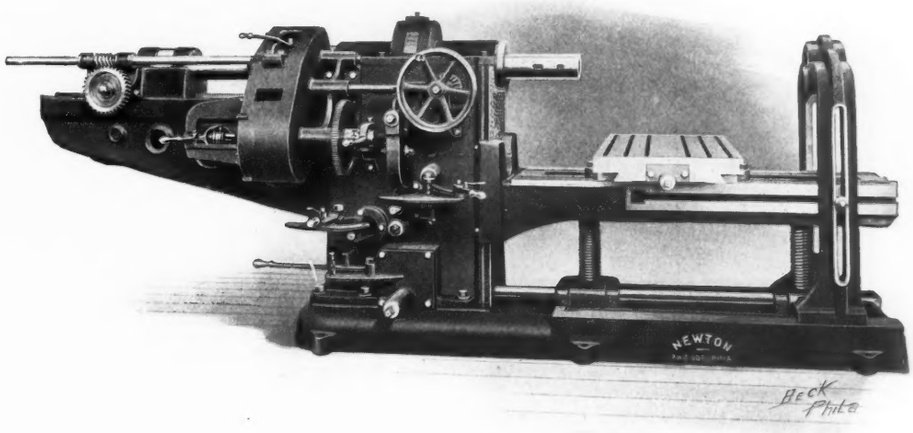
Radial Drilling Machines

Bolt Threading Machines

Crank Slotting Machines

Multiple Spindle Boring Machines

HORIZONTAL BORING, DRILLING AND MILLING MACHINE

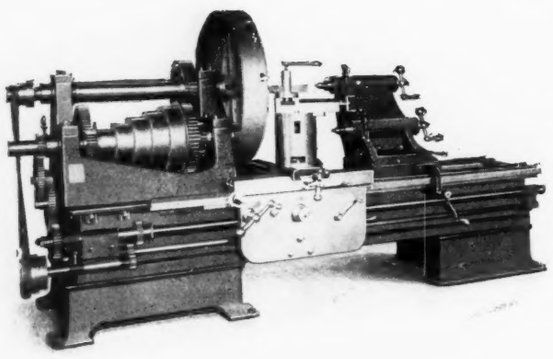


HORIZONTAL BORING MACHINE—Single Belt Drive

Newton Machine Tool Works, Inc.

Philadelphia, U. S. A.

FOREIGN REPRESENTATIVES—Berlin, Heinrich Dreyer. Vienna, Rudolph Salzer. Italy, Spain, Switzerland, Belgium and France, Fenwick, Freres & Co., Paris, France.



"Yesterday"

"A return to first principles," showing one of our former styles, light pattern Double-Spindle Lathes.

It was our "best" then.

"If each year didn't show improvement there wouldn't be much use in having the experience."

There is now—

—more capacity
—more power
—more strength
—more rigidity
—more facilities
—more conveniences

more Lathe in McCabe's "New style" 2-in-1 Lathe than any other big Lathe selling at $1,000 more.

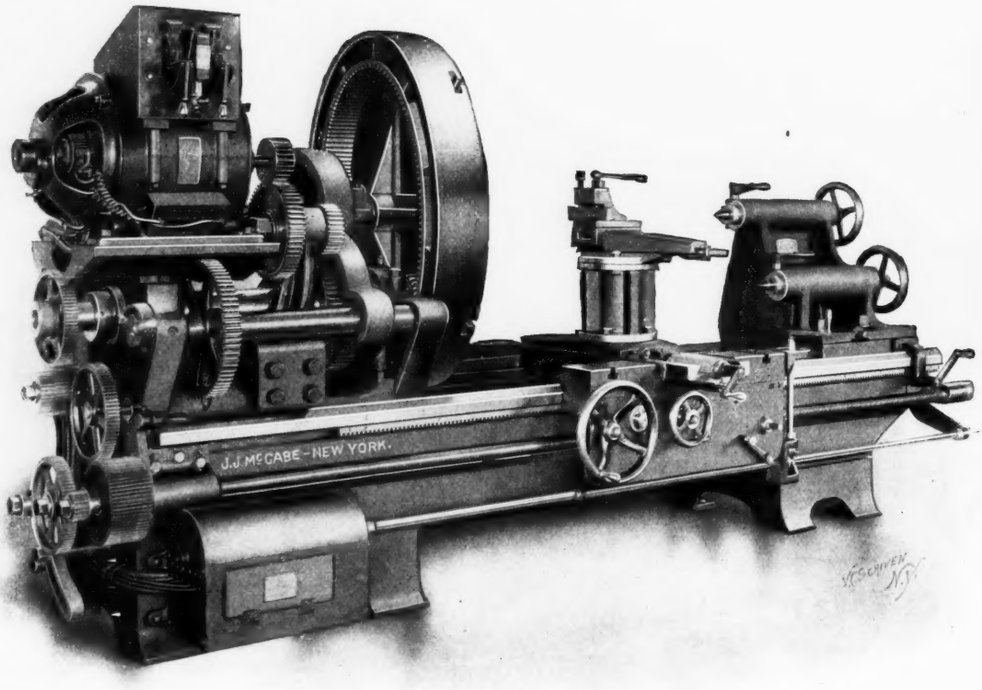
J. J. McCabe, 30 Church St., New York

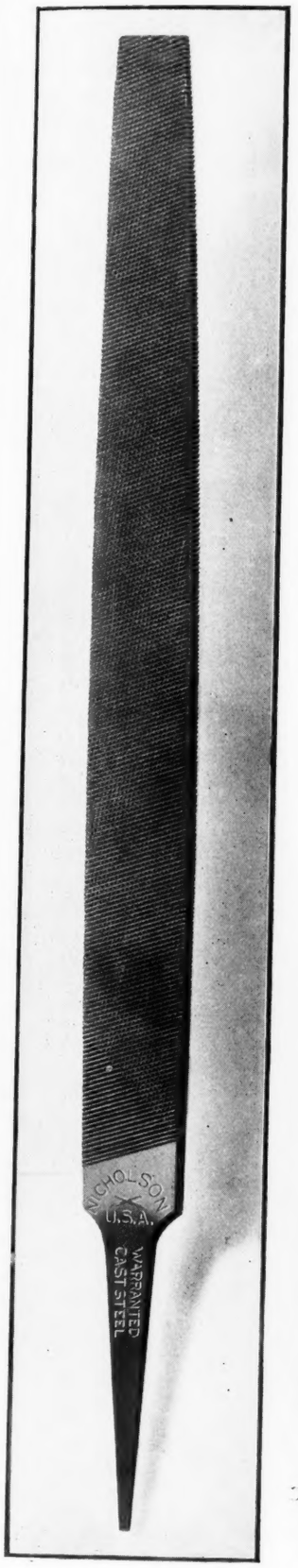
"To-Day"

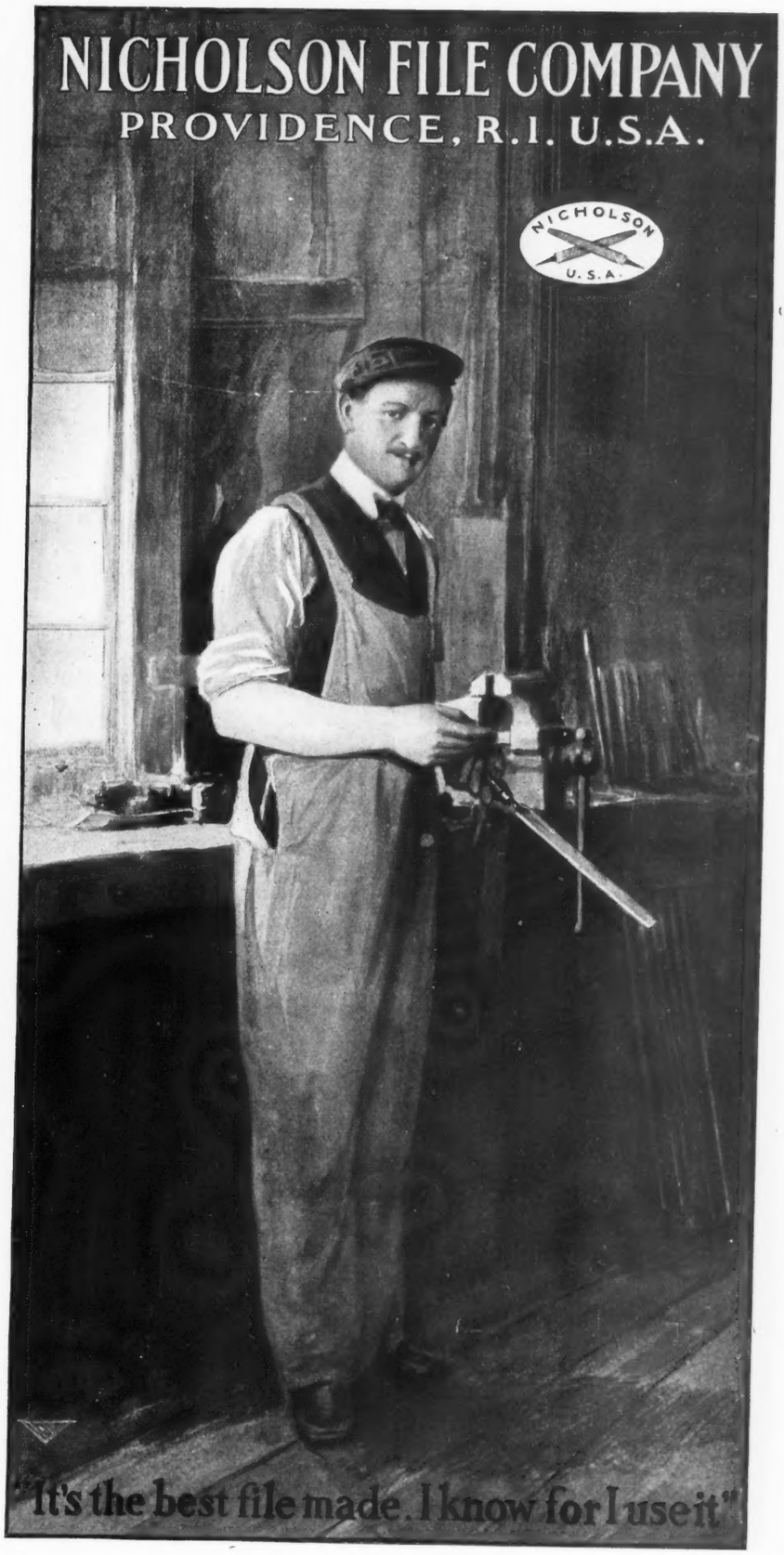
"New style heavy pattern"

26-48" swing

Showing also Direct-connected Motor Drive.




NICHOLSON
U.S.A.
WARRANTED
CAST STEEL


NICHOLSON FILE COMPANY
PROVIDENCE, R.I. U.S.A.
NICHOLSON
U.S.A.
"It's the best file made. I know for I use it"

The Cincinnati Stationary Head Complete Drill with Tapping Attachment.

Metal Drilling Machinery

The Machines Formerly Made By

Cincinnati Machine Tool Co.
The Bickford Drill and Tool Co.

This is the largest and most complete line of UPRIGHT, PLAIN RADIAL, SEMI-RADIAL, HALF and FULL UNIVERSAL RADIAL DRILLS, also MULTIPLE DRILLS, GANG DRILLS and TAPPING MACHINES made in the world.

THE CINCINNATI 21" Stationary Head Complete Drill, with wheel and lever feed, back gear, power feed and automatic stop and also Patent Geared Tapping Attachment directly on the spindle, as shown herewith, is the most complete tool of its kind now on the market.

The Patent Geared Tapping Attachment can be completely disengaged when no tapping is to be done and this machine has an instantaneous stop for the spindle while changing chucks or drills.

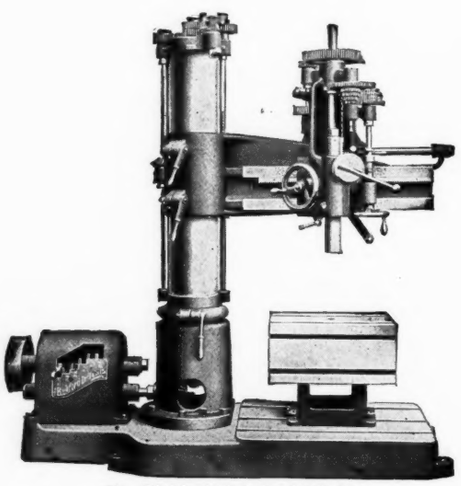
THE BICKFORD Plain Radial Drill is made in six sizes and twenty-four styles. The cut shown herewith represents the 2½, 3 and 3½′ machine. This machine is furnished with three styles of drives, cone, gear and motor and with three styles of tables, box, swinging and swiveling.

This machine is simple in design, rigid in construction, easily manipulated, has durability of wearing parts and will produce a volume of output and accuracy of work greater than any other drill on the market.

The Cincinnati Bickford Tool Co.

Cincinnati, Ohio, U. S. A.

DOMESTIC AGENTS—Prentiss Tool & Supply Co., New York, N. Y., Boston, Mass., Buffalo and Syracuse, N. Y.; W. E. Shipley Machinery Co., Philadelphia, Pa.; Brown & Zortman Machinery Co., Pittsburg, Pa.; Motch & Merryweather Machinery Co. Cleveland, Ohio, and Detroit, Mich.; Marshall & Huschart Machinery Co., Chicago, Ill., Indianapolis, Ind., St. Louis, Mo.; Robinson, Cary & Sands Co., St. Paul and Duluth, Minn., Hallidie Machinery Co., Seattle and Spokane, Wash., Zimmerman-Wells-Brown Co., Portland, Ore.; Harron-Rickard & McCone, San Francisco, and Los Angeles, Cal.; Utah Mining Machinery & Supply Co., Salt Lake City, Utah; C. T. Patterson, Ltd., New Orleans, La.; M. E. Dewstoe, Birmingham, Ala.; Morrison Machinery & Supply Co., Richmond, Va.



The Bickford Plain Radial Drill

"THE PURCHASE OF A NATIONAL HEADER INVOLVES AN INVESTMENT OF 18½ per cent. (average) MORE CAPITAL THAN THE PURCHASE OF A TOOL OF EQUAL CAPACITY FROM THE FIELD OF COMPETITION."

Ponder over that—and we call it, "an investment."

But PRICE is not the distinctive feature of National Headers, altho if we said no more t'would make you think—t'would make all men who know Headers think—and want to investigate the "why" of that higher first cost.

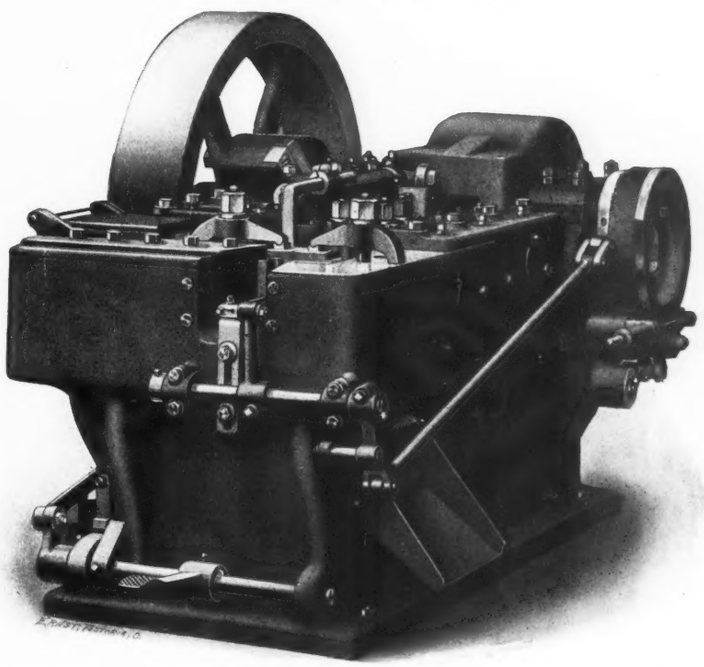
You'd have a theory, of course.

And if we could take you thru the "National" factory and show you National Headers in the course of construction, from the rough castings and materials to the finished parts, you'd appreciate their simple and rigid lines; on the assembling floor you'd see the minute details entered into and the exacting care taken—we'd not have to point them out; then, the testing floor where all National Headers are given a thoro tryout, final adjustments and alignments made, and a general inspection by an expert.

[And you'd enjoy immensely your trip thru that "daylight" plant of ours.]

Now you begin to comprehend.

A "NATIONAL" PRODUCT



THE WEDGE GRIP HEADER

Built in Sizes: ¾, 1, 1¼ and 1½ inch for continuous rivet work. 1, 1⅝, 2 and 2½ inch for bolt and forging work.

But that's not all, we'd go farther, we'd take you to the finest bolt shops in the States and show you National Headers in operation, alongside of other makes, under regular working conditions—not on "fixed" jobs in our own shops.

THEN YOU'D UNDERSTAND, and we'd let you decide whether that additional outlay of capital was "AN INVESTMENT" or an expense.

If you're interested in Headers, tell us, and ask for CATALOG "E."

"OUR LINE"

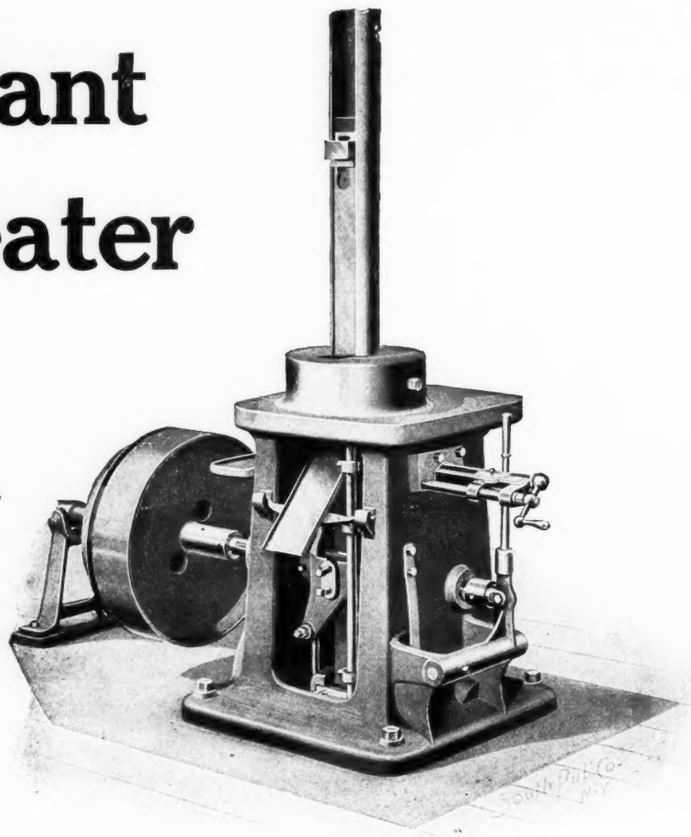
Bolt Cutters
Roll Thread Machines
Bolt Pointers
Lag Screw Pointers
Bolt Headers
Rivet Headers
Forging Machines
Nut Machines
Nut Tappers
Washer Machines
Wire Nail Machines

THE NATIONAL MACHINERY CO.
TIFFIN, OHIO, U.S.A.

FOREIGN AGENTS

Fenwick, Freres & Co., Paris, Liege, Brussels.
Buck & Hickman, Ltd., London, Manchester, Birmingham, Glasgow.
Takata & Co., Tokio, Japan.
A. B. Horn, Havana, Cuba.
White, Child & Beney, Vienna, Budapest.
V. Lowener, Stockholm, Copenhagen, Christiania.
Bevan & Edwards, Propty, Ltd., Melbourne, Australia.
H. W. Petrie, Toronto Vancouver.

The Giant Key-Seater



"Produces the Goods"

The Giant will finish two ordinary key-seats in the time it usually takes to fasten one piece ready for key-seating on any other style machine.

It is not necessary to face the hub true—the Giant cuts accurate key-ways, straight or taper, whether the hub is faced or left rough as it comes from the foundry.

It is adapted for all materials, and to work under all conditions—especially valuable for hard steel hubs, as it is impossible for the cutter to spring back, no matter how hard the material.

A grooved post which holds the work and forms a guide for the tool permits every job to be set and fastened by the bore alone.

You can save time, labor and money in your key-seating work by installing the Giant Key-Seater—six sizes and every one a winner.

Ask for the book.

MITTS & MERRILL, Saginaw, Mich.

843 WATER STREET

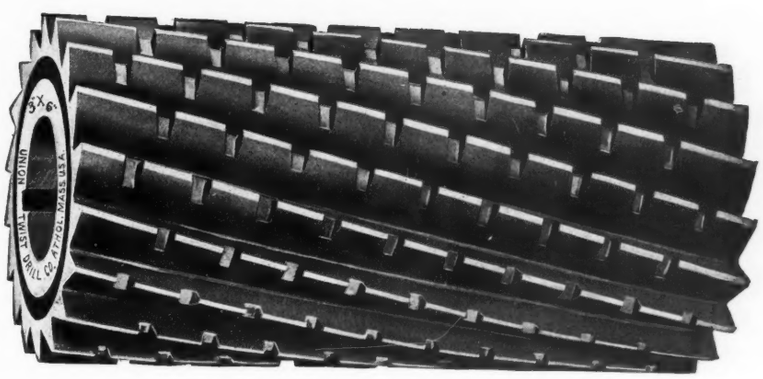
FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, England. Heinrich Dreyer, Berlin, Germany, Austria and Russia. J. E. Chabert & Co., Paris, France, Belgium and Switzerland.

MILLING AND GEAR CUTTERS

We give you accuracy and quality—from the most complete plant in this country arranged especially for the production of cutters that are High Grade in every respect.

Carbon or High Speed

Write for prices— They will also interest you

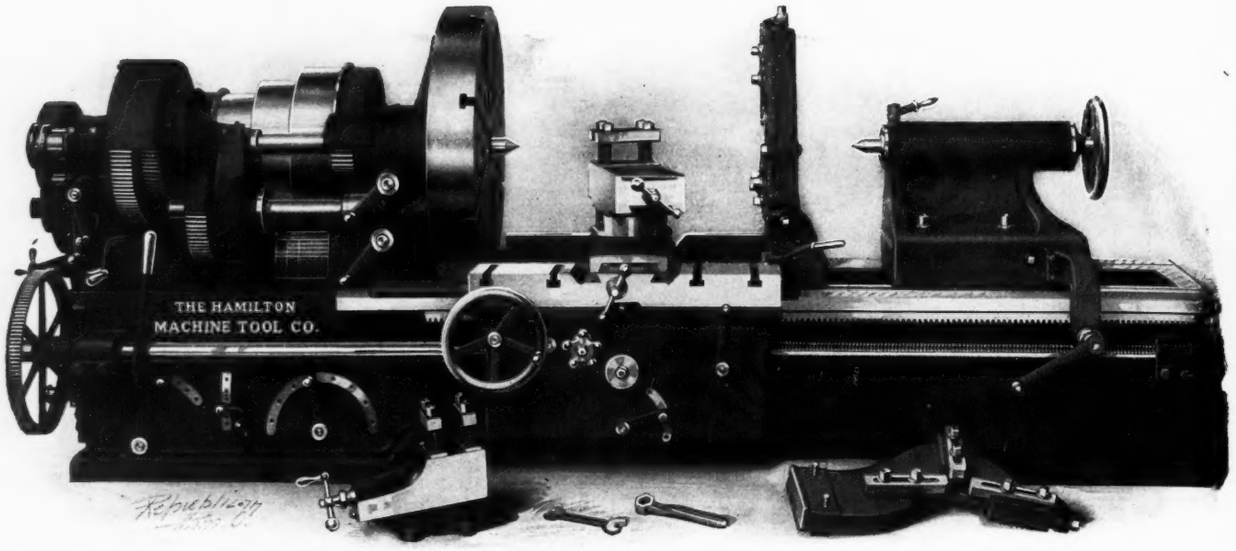


UNION TWIST DRILL CO., Athol, Mass.

THE CUTTER MAKERS

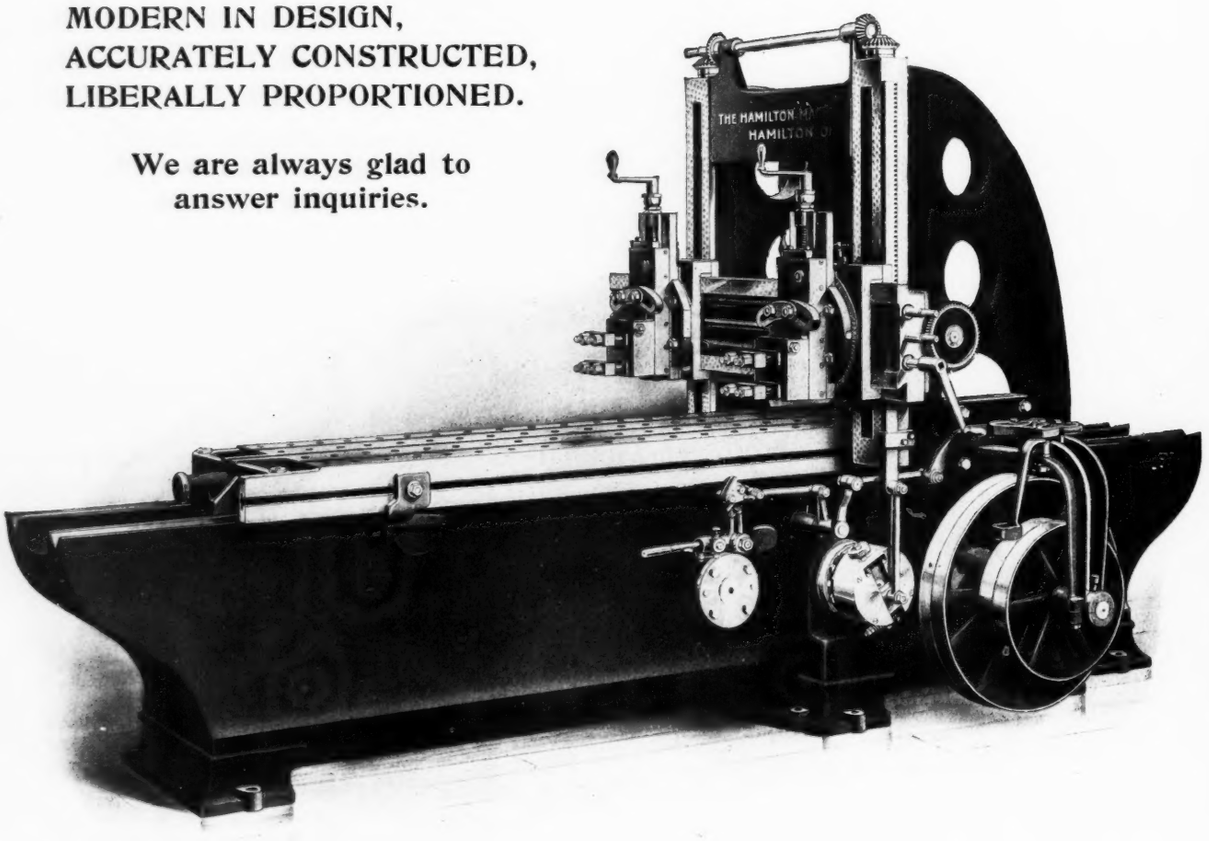
"HAMILTON"

Lathes, Planers, Shapers, Upright and Radial Drills



MODERN IN DESIGN,
ACCURATELY CONSTRUCTED,
LIBERALLY PROPORTIONED.

We are always glad to
answer inquiries.



The Hamilton Machine Tool Co., Hamilton, Ohio

CLEVELAND STORE: 202-204 St. Clair Ave., N. E., W. H. Welch, Manager

PHILADELPHIA STORE: 48-50 N. Sixth St., E. L. Fraser, Manager

THE WINNER

Of course it's a

"PEERLESS" REAMER

WHY?

FIRST

It has the Speed

Can be run two or three times as fast as an ordinary reamer.

SECOND

It has the Strength

A soft body tougher than tool steel, into which are solidly brazed High Speed Blades absolutely guaranteed against working loose.

THIRD

It has the Endurance

The soft body allows unusual expansion, thus prolonging the life of the reamer after the blades begin to wear down.

Catalogue 36-M explains it.

The CLEVELAND Twist Drill Co.

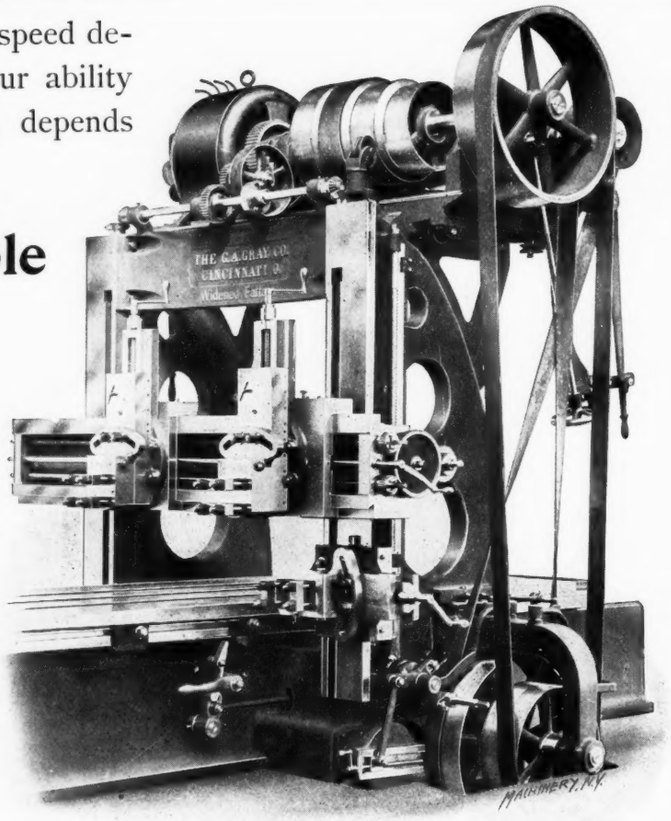
NEW YORK CLEVELAND, OHIO CHICAGO

THE most economical cutting speed depends upon the work. Your ability to satisfactorily use this speed depends upon the planer.

The Gray Variable Speed Planer

enables you to use the desired speed without sacrificing the accuracy and smooth running which has always characterized their single speed planers.

Send for special circular describing Gray Variable Speed Planers.



The G. A. Gray Company
CINCINNATI, OHIO

STOCKBRIDGE

A Perfect Crank Motion

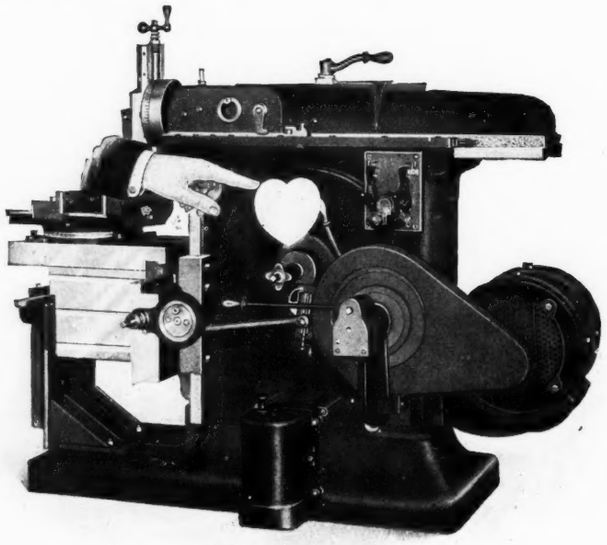
Stockbridge Patented Two-Piece-Crank Motion gives an even cutting speed the entire length of cut and on a 24″ shaper (as shown) a 3 to 1 quick return.

The greatest thing in a crank motion that ever went inside a shaper.

Circular on request.

STOCKBRIDGE

THE HEART OF A SHAPER IS ITS CRANK



STOCKBRIDGE MACHINE CO.
WORCESTER, MASS.

New York Office: Niles-Bement-Pond Co., 111 Broadway

BARNES DRILLS

WITH A

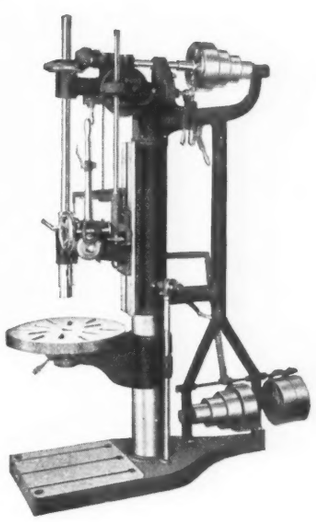
POSITIVE FEED that makes "them tell"

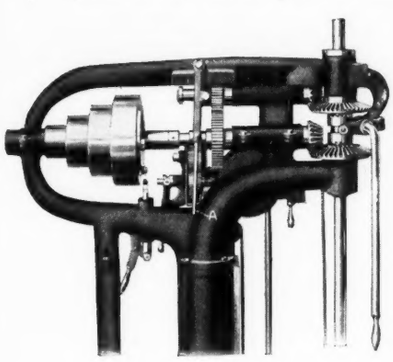
8 changes of feed on 26 to 50" swing drills

4 changes on 20 to 25" swing

A feed adapted to drilling, reaming, boring, facing, etc.

We make a most complete line of Upright Drills; also Gang Drills and Horizontal Radial Drills. The real way to know what we make is to let us send our up-to-date Drill Catalog; look it over and if not wanting tools just now, then put it in your files for future reference.





Our tools are not in the experimental stage, but tried out and thousands are in use, giving the best of satisfaction. For instance:—look at our Positive Feed (been in the market since 1903) leads 'em all and to-day stands at the top in merit, strength and convenience of operating. Look at our Geared Tapping Attachment; the acme of perfection. Why? Because it has no studs for the gears but is equipped with shafts and long boxes, which give it strength and endurance; it works like a charm and does not jar when reversed.

Look at our Internal Back Gearing; been on the market since 1885; the most perfected back gearing offered. Why? Because it has strength and endurance; is neat, compact and throws no oil.

Consider the material in our drills:—We don't put cheap stuff in them; we can't do it and hold up our reputation; if we did use cheap stuff, you would find it out sooner or later and we would suffer just as much as yourselves. For instance, we make our own castings and use charcoal iron and the best grade of southern iron; we use a high priced babbitt metal for all bearings and you will appreciate its enduring qualities.

Accuracy is our "motto"; we give each machine and each part a most careful test and thus are able to produce a finely finished and accurate machine.

SEND FOR CATALOG.

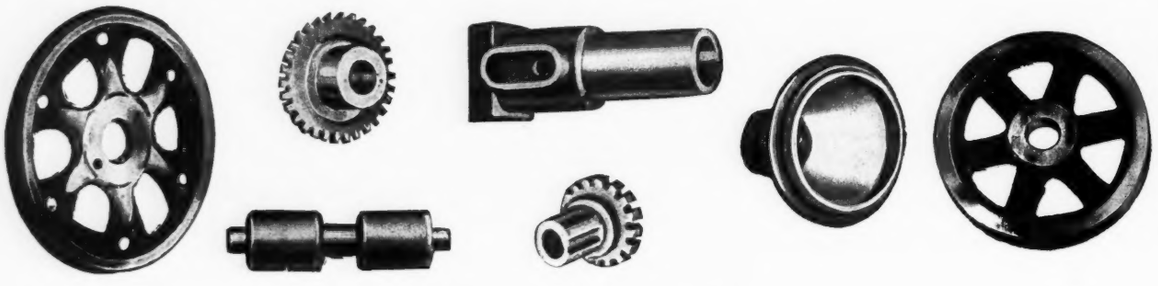
W. F. & JOHN BARNES COMPANY

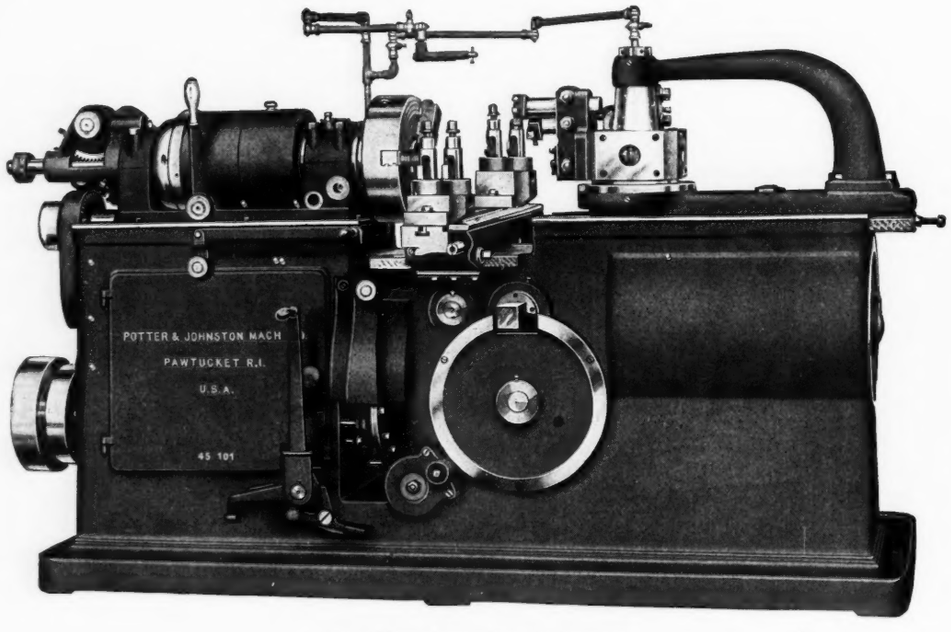
231 Ruby Street, ROCKFORD, ILL., U. S. A.

Potter & Johnston Manufacturing Automatics

For Handling Duplicate Parts in Great Variety from Castings of Iron, Brass, Steel, also Forgings and Bar Work.

Built in several sizes and combinations, with a range of turning diameters up to 20 inches and 9½ inches long.





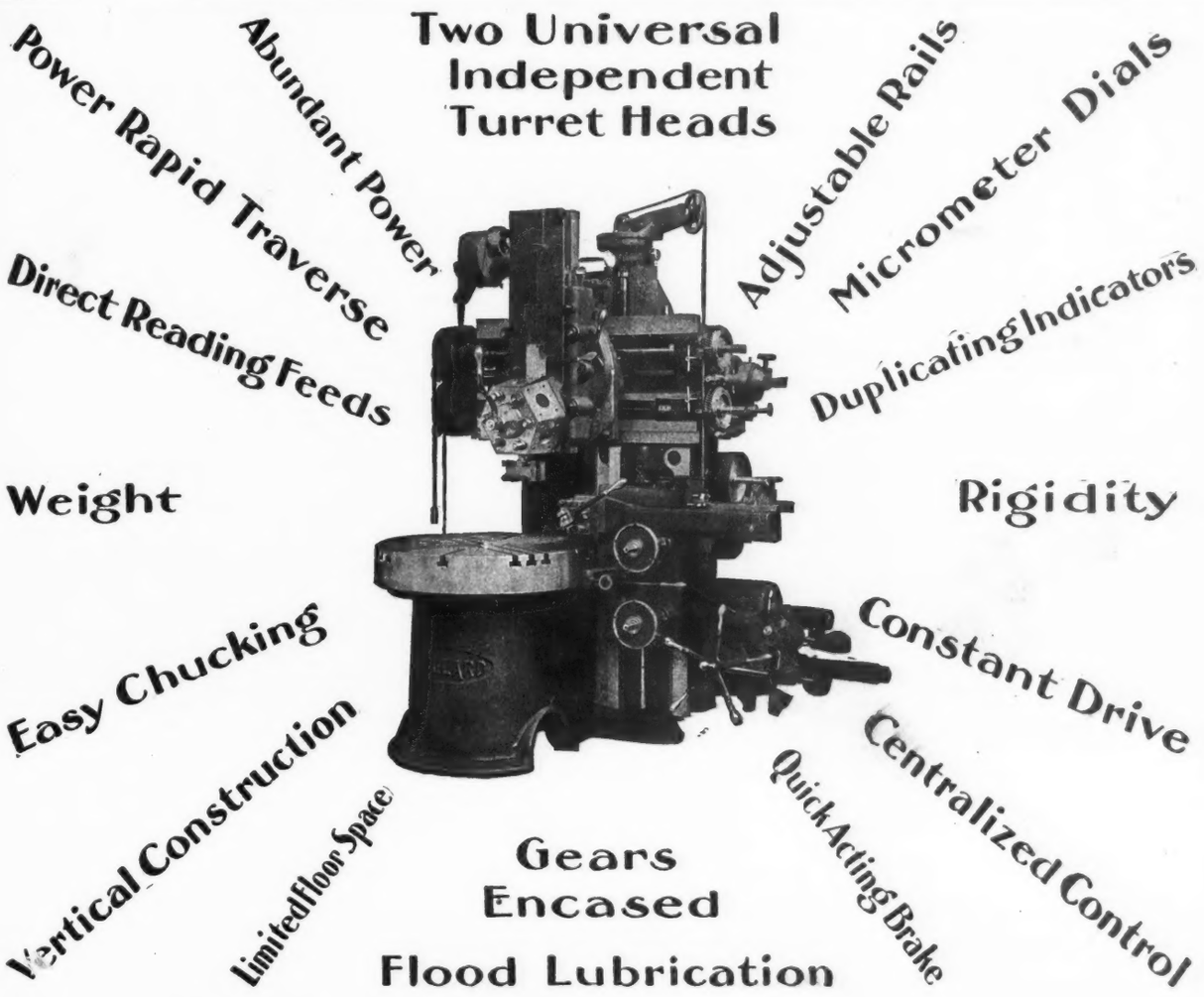
5-A Manufacturing Automatic.

ALL CUTTING OPERATIONS AUTOMATICALLY PERFORMED.
ONE ATTENDANT OPERATES IN GROUPS OF 4 TO 6 MACHINES.

Send us drawings or samples of your duplicate parts for production estimates. Catalog?

POTTER & JOHNSTON, Pawtucket, R. I., U.S.A.

OFFICES AND REPRESENTATIVES—Paris Office, 78 Avenue de la Grand Armee, J. Ryan, Manager. New York Office, 50 Church St., Walter H. Foster, Manager. Cleveland Office, 309 Schofield Bldg., Modern Machinery & Engineering Co., Representatives.
FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England and Glasgow, Scotland. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Barcelona, Bilbao. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest.



The essentials of Rapid Production are focused in the design of

BULLARD

Vertical Turret Lathes

24-INCH == 36-INCH

A highly developed machine tool of distinctive type, embodying in its design all desirable features of the *horizontal* turret lathe, combined with those of the vertical boring and turning mill, in such a manner as to insure a maximum output, with minimum effort, in the production of face plate work.

A machine of this type will be in operation at the M. M. & M. C. B. Convention Exhibit, Young's Million Dollar Pier, Atlantic City, June 16-23 inclusive. It is to your interest to see it.

The Bullard Machine Tool Co.

Bridgeport, Conn., U. S. A.

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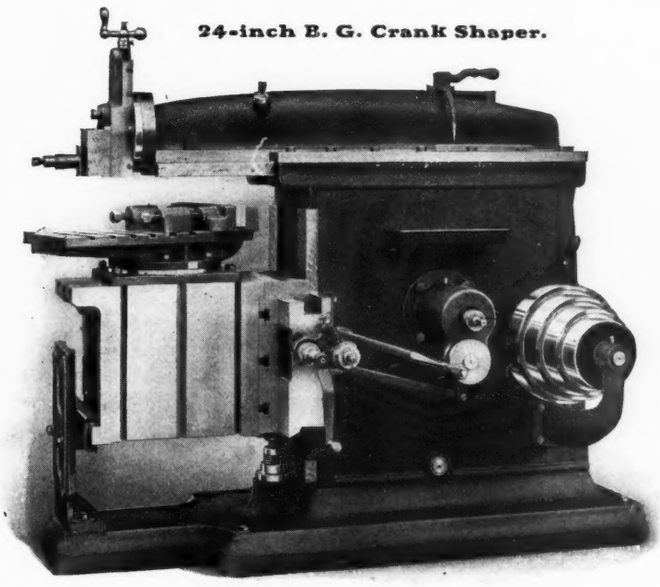
24-inch B. G. Crank Shaper.



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We will show you the most ACCURATE Shaper you ever saw; the most CONVENIENT Shaper you ever saw; the most POWERFUL Shaper you ever saw; we will show you can produce MORE WORK and BETTER WORK than with any other of equal stroke.

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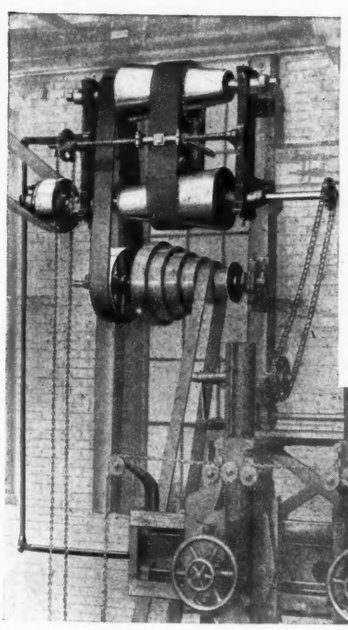

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Is used successfully for driving

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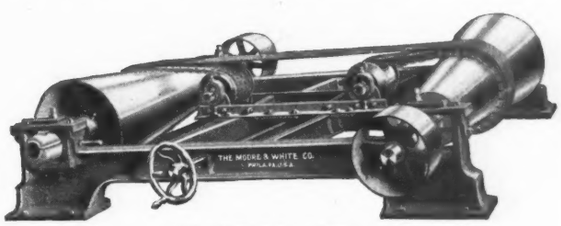

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It is strong, compact, may be placed on the floor or ceiling and is adapted for machinery of all kinds.

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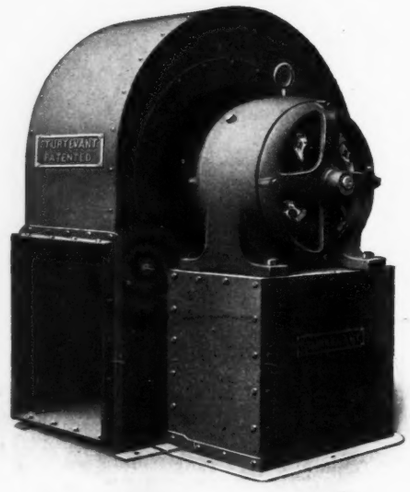

You employ a lawyer or doctor purely on confidence because you are not skilled in these professions.

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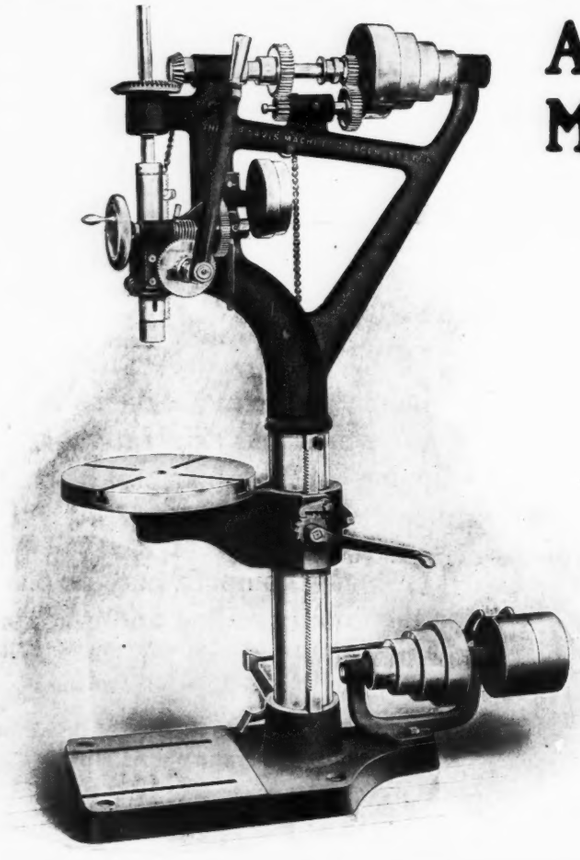

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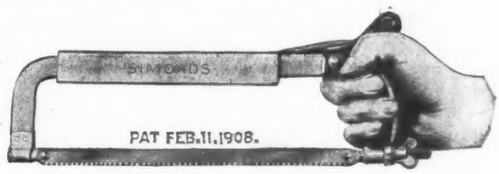

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Glad to give you full particulars.

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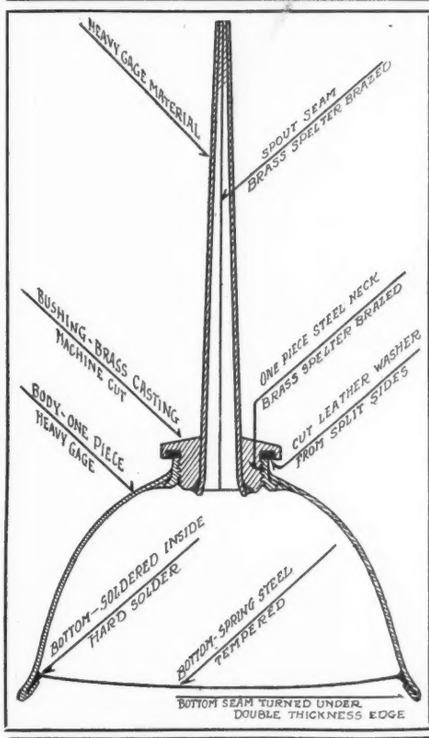
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BOTTOM-SPRING STEEL TEMPERED
BOTTOM SEAM TURNED UNDER DOUBLE THICKNESS EDGE

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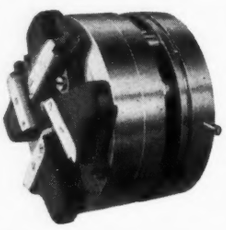

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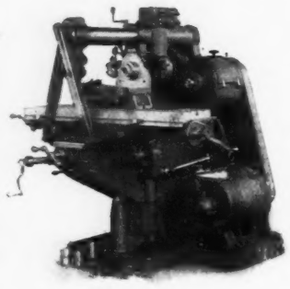

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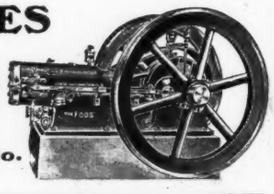

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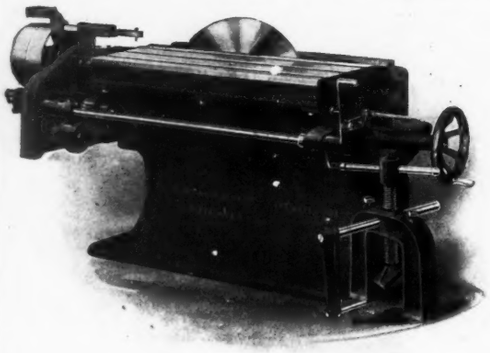

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Fellows Gear Shaper Co., Springfield, Vt.
Flather, E. J., Mfg. Co., Nashua, N. H.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Newark Gear Cutting Mch. Co., Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.
Reynolds Mchy. Co., Moline, Ill.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Waltham Machine Works, Waltham, Mass.
Whiton, D. E., Mch. Co., New London, Conn.

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Gear Planers, Bevel.
Gleason Works, Rochester, N. Y.

Gear Shapers.
Fellows Gear Shaper Co., Springfield, Vt.

Generators.
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Elec. Works, Fort Wayne, Ind.
General Elec. Co., Schenectady, N. Y.
Sprague Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Graphite.
Dixon, Jos., Crucible Co., Jersey City, N. J.

Grinders, Portable, Electrical Driven.
Cincinnati Elec. Tool Co., Cincinnati, O.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mch. Co., Cincinnati, O.
United States Elec. Tool Co., Cincinnati, O.

Grinding Machinery.
Barnes, W. F. & J., Co., Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Becker Milling Mch. Co., Hyde Park, Mass.
Besly, C. H., & Co., Chicago, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Crescent Mch. Co., Leetonia, O.
Diamond Mch. Co., Providence, R. I.
Gould & Eberhardt, Newark, N. J.
Graham Mfg. Co., Providence, R. I.
Hisey-Wolf Mch. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
La Salle Mch. & Tool Co., La Salle, Ill.
Lutter & Gies, Milwaukee, Wis.
Modern Tool Co., Erie, Pa.
Monarch Emery & Corundum Wheel Co., Camden, N. J.
Mummert, Wolf & Dixon Co., Hanover, Pa.
Newark Gear Cutting Mch. Co., Newark, N. J.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Ransom Mfg. Co., Oshkosh, Wis.
Rockford Drilling Mch. Co., Rockford, Ill.
Rowbottom Mch. Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Walker, O. S., & Co., Worcester, Mass.
Wells, F. E., & Son Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Grinding Machines, Plain, Universal.
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dayton Mch. & Tool Wks., Dayton, O.
Greenfield Mch. Co., Greenfield, Mass.
Landis Tool Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.

Hack Saw Frames.
Simonds Mfg. Co., Fitchburg, Mass.
West Haven Mfg. Co., New Haven, Conn.

Hammers, Power.
Beaudry & Co., Inc., Boston, Mass.
Niles-Bement-Pond Co., New York.
Scranton & Co., New Haven, Conn.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Williams, White & Co., Moline, Ill.

Hammers, Power, Steam and Drop.
Beaudry & Co., Inc., Boston, Mass.
Billings & Spencer Co., Hartford, Conn.
Bliss, E. W., Co., Brooklyn, N. Y.
Bradley, C. C., & Son, Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Dieneit & Eisenhardt, Philadelphia, Pa.
Merrill Bros., Brooklyn, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., New Haven, Conn.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Williams, White & Co., Moline, Ill.

Handles, Machine Tool.
Cincinnati Ball Crank Co., Cincinnati, O.

Hardening and Tempering.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Coes Wrench Co., Worcester, Mass.

Heading, Upsetting and Forging Machines.
Acme Machinery Co., Cleveland, O.
Ajax Mfg. Co., Cleveland, O.
Bliss, E. W., Co., Brooklyn, N. Y.
Brown, H. B., Co., East Hampton, Conn.
National Mchy. Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Williams, White & Co., Moline, Ill.

Heating and Ventilating, Dust Collecting Systems.
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant, B. F., Co., Hyde Park, Mass.

Heating Machines.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Heaters.
Sturtevant, B. F., Co., Hyde Park, Mass.

Heaters, Feed Water.
Stewart Heater Co., Buffalo, N. Y.

Hoisting Machinery.
Detroit Hoist & Mch. Co., Detroit, Mich.

Hoists.
Cleveland Crane & Engr. Co., Wickliffe, Ohio.
Mason, Volney W., & Co., Providence, R. I.
Niles-Bement-Pond Co., New York.

Hoists, Chain.
Harrington, Edwin, & Son, Inc., Philadelphia.
Niles-Bement-Pond Co., New York.
Yale & Towne Mfg. Co., New York.

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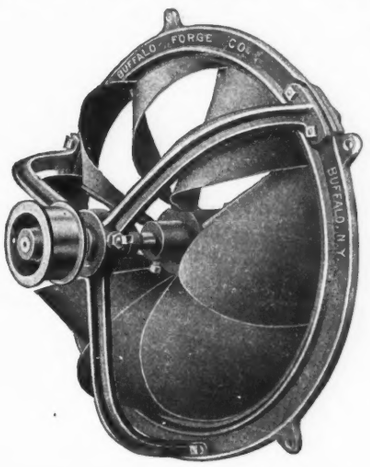

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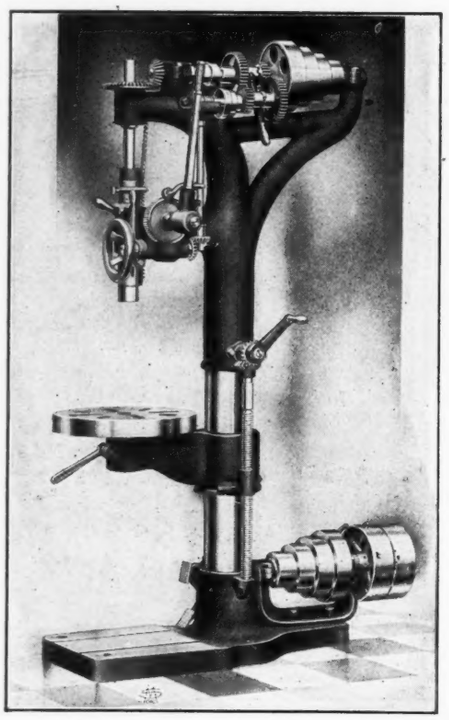

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Link-Belt Co., Philadelphia, Pa.
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Northern Engineering Wks., Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Shepard Elec. Crane & Hoist Co., Montour Falls.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Detroit Hoist & Mch. Co., Detroit, Mich.
Northern Engineering Wks., Detroit, Mich.
Shepard Elec. Crane & Hoist Co., Montour Falls.
Stow Flexible Shaft Co., Philadelphia, Pa.

Hydraulic Machinery.
Chambersburg Engineering Co., Chambersburg, Pa.
Niles-Bement-Pond Co., New York.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

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Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

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Starrett, L. S., Co., Athol, Mass.
Woodman, R., Mfg. & Supply Co., Boston, Mass.

Injectors.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.

Jacks.
Dienelt & Eisenhardt, Philadelphia, Pa.
Watson-Stillman Co., New York.

Jigs.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.

Key-Seaters.
Baker Bros, Toledo, O.
Burr, John T., & Sons, Brooklyn, N. Y.
Davis, W. P., Mch. Co., Rochester, N. Y.
Mitts & Merrill, Saginaw, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., New York.
Rockford Drilling Mch. Co., Rockford, Ill.

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Cooper-Hewitt Electric Co., New York.
General Electric Co., Schenectady, N. Y.

Lathes.
American Tool Works Co., Cincinnati, O.
Automatic Mch. Co., Bridgeport, Conn.
Barnes, W. F. & J., Co., Rockford, Ill.
Barnes Drill Co., Rockford, Ill.
Bradford Machine Tool Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mch. Tool Co., Bridgeport, Conn.
Carroll-Jamieson Mch. Tool Co., Batavia, Ohio.
Champion Tool Wks. Co., Cincinnati, O.
Cincinnati Lathe & Tool Co., Cincinnati, O.
Davis, W. P., Mch. Co., Rochester, N. Y.
Detrick & Harvey Mch. Co., Baltimore, Md.
Elgin Tool Works, Elgin, Ill.
Fay Mch. Tool Co., Philadelphia, Pa.
Fay & Scott, Dexter, Me.
Fitchburg Mch. Wks., Fitchburg, Mass.
Flather & Co., Nashua, N. H.
Garvin Mch. Co., New York.
Gisholt Mch. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Greaves, Klusman & Co., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O.
Hardinge Bros., Chicago, Ill.
Hendey Mch. Co., Torrington, Conn.
International Mch. Tool Co., Indianapolis, Ind.
Jones & Lamson Mch. Co., Springfield, Vt.
Le Blond, R. K., Mch. Tool Co., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
Milwaukee Mch. Tool Co., Milwaukee, Wis.
Morris, J. B., Fdry. Co., Cincinnati, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Prentice, Geo. G., & Co., New Haven, Conn.
Reed, F. E., Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Brighton, Mass.
Robbins Mch. Co., Worcester, Mass.
Rockford Drilling Mch. Co., Rockford, Ill.
Schumacher & Boye, Cincinnati, O.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.
Smurr & Kamen Mch. Co., Chicago, Ill.
Springfield Mch. Tool Co., Springfield, O.
Steinle Turret Mch. Co., Madison, Wis.
Stark Tool Co., Waltham, Mass.
Von Wyck Mch. Tool Co., Cincinnati, O.
Walcott & Wood Mch. Tool Co., Jackson, Mich.
Waltham Mch. Wks., Waltham, Mass.
Warner & Swasey Co., Cleveland, O.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.

Lathes, Pulley.
Cincinnati Pulley Mchy. Co., Cincinnati, O.

Lathe and Planer Tools.
Armstrong Bros. Tool Co., Chicago, Ill.
Le Blond, R. K., Mch. Tool Co., Cincinnati, O.
Le Count, William G., Norwalk, Conn.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Williams, J. H., & Co., Brooklyn, N. Y.

Lockers.
Lyon Metallic Mfg. Co., Aurora, Ill.

Lubricants.
Besly, C. H., & Co., Chicago, Ill.
Carpenter, Walter D., Co., New York.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Walton, R. S., Co., Philadelphia, Pa.

Machine Keys.
Morton Mfg. Co., Muskegon Heights, Mich.
Olney & Warrin, New York.
Standard Gauge Steel Co., Beaver Falls, Pa.

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Machinery Dealers, Domestic.
Garvin Mch. Co., New York.
Hill, Clarke & Co., Chicago, Ill.
McCabe, J. J., New York.
Motch & Merryweather Mchy. Co., Cleveland, O.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Vandyck Churchill Co., New York.

Machinists' Small Tools.
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Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., New York.
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Slocomb, J. T., Co., Providence, R. I.
Smith, E. G., Co., Columbia, Pa.
Standard Tool Co., Cleveland, O.
Starrett, L. S., Co., Athol, Mass.
Syracuse Twist Drill Co., Syracuse, N. Y.
Welles, F. A., Waukesha, Wis.
Wells Bros. Co., Greenfield, Mass.
Wyke, J., & Co., Boston, Mass.

Mandrels.
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Nicholson, W. H., & Co., Wilkesbarre, Pa.
Pratt & Whitney Co., Hartford, Conn.
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Western Tool & Mfg. Co., Springfield, O.

Mechanical Draft.
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant, B. F., Co., Hyde Park, Mass.

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Goldschmidt Thermit Co., New York.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
Reeves, P. S., & Son, Philadelphia, Pa.

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Hoffman, George W., Indianapolis, Ind.

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Porter-Cable Mch. Co., Syracuse, N. Y.

Milling Cutters.
Becker Milling Mch. Co., Hyde Park, Mass.
Boker, Hermann, & Co., New York and Chicago.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Garvin Mch. Co., New York.
Huther Bros. Saw Mfg. Co., Rochester, N. Y.
Morse Twist Drill & Mch. Co., New Bedford.
National Tool Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Standard Tool Co., Cleveland, O.
Starrett, L. S., Co., Athol, Mass.
Tabor Mfg. Co., Philadelphia, Pa.
Union Twist Drill Co., Athol, Mass.

Milling Machines.
Adams Co., Dubuque, Ia.
Beaman & Smith Co., Providence, R. I.
Becker Milling Mch. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Mchy. Co., Cleveland, O.
Chicago Mch. Tool Co., Chicago, Ill.
Cincinnati Milling Mch. Co., Cincinnati, O.
Dalin Bros., Rockford, Ill.
Fox Mch. Co., Grand Rapids, Mich.
Garvin Mch. Co., New York.
Hendey Mch. Co., Torrington, Conn.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
Knight, W. B., Mchy. Co., St. Louis, Mo.
Le Blond, R. K., Mch. Tool Co., Cincinnati, O.
Newton Mch. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Owen Mch. Tool Co., Springfield, O.
Pratt & Whitney Co., Hartford, Conn.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Universal Boring Mch. Co., Hudson, Mass.
Waltham Watch Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Milling Tools (Hollow Adjustable).
Geometric Tool Co., New Haven, Conn.
Rogers, J. M., Works, Gloucester City, N. J.

Molding Machines.
Adams Co., Dubuque, Ia.

Motors (Electric).
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Elec. Works, Fort Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, O.
Sprague Elec. Co., New York.
Sturtevant, B. F., Co., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Name Plates.
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Nozzles.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Nut Tappers.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.

Oil Cans.
Delphos Mfg. Co., Delphos, O.

Oil Cups.
Bay State Stamping Co., Worcester, Mass.
Besly, C. H., & Co., Chicago, Ill.
Tucker, W. M. & C. F., Hartford, Conn.
Winkley Co., Detroit, Mich.

Oilers.
Gem Mfg. Co., Pittsburg, Pa.

Oil Hole Covers.
Bay State Stamping Co., Worcester, Mass.
Tucker, W. M. & C. F., Hartford, Conn.
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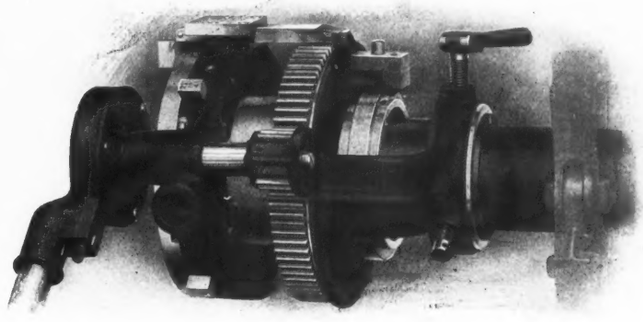

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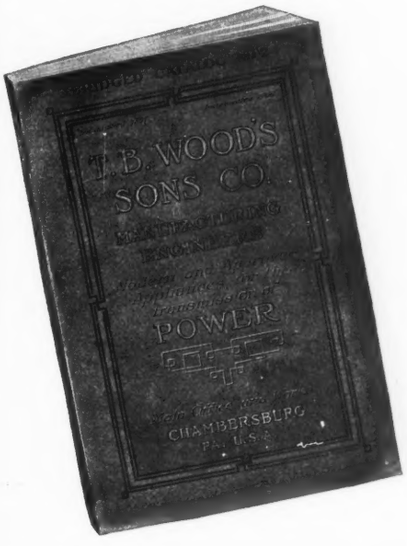

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Howson & Howson, Philadelphia, Pa.
MacDonald & MacDonald, New York.
Parker, C. L., Washington, D. C.
Whittlesey, Geo. P., Washington, D. C.

Pattern Shop Equipment.
Colburn Mch. Tool Co., Franklin, Pa.
Fox Machine Co., Grand Rapids, Mich.

Phosphorizers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Pipe-Cutting and Threading Tools.
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Curtis & Curtis Co., Bridgeport, Conn.
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Stoever Fdry. & Mfg. Co., Myerstown, Pa.
Trimont Mfg. Co., Roxbury, Mass.

Pipes and Fittings.
National Tube Co., Pittsburg, Pa.

Planers, Metal.
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Betts Mch. Co., Wilmington, Del.
Cincinnati Planer Co., Cincinnati, O.
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Whitcomb-Blaisdell Mch. Tool Co., Worcester.
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Wilson, W. A., Mch. Co., Rochester, N. Y.
Woodward & Powell Planer Co., Worcester, Mass.

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Detroit Hoist & Mch. Co., Detroit, Mich.

Pneumatic Tools.
Bliss, E. W., Co., Brooklyn, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Shepard Elec. Crane & Hoist Co., Montour Falls.

Portable Tools, Repair, Railroad, etc.
Underwood, H. B., & Co., Philadelphia, Pa.

Presses.
Billings & Spencer Co., Hartford, Conn.
Bliss, E. W., Co., Brooklyn, N. Y.
Ferracute Mch. Co., Bridgeton, N. J.
Garvin Mch. Co., New York.
Hamilton Mch. Tool Co., Hamilton, O.
Hoefer Mfg. Co., Freeport, Ill.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Presses, Power Forcing.
Lucas Machine Tool Co., Cleveland, O.

Pulley Blocks.
Yale & Towne Mfg. Co., New York.

Pulleys.
American Pulley Co., Philadelphia, Pa.
Philips Pressed Steel Co., Philadelphia, Pa.
Poole Eng'rg & Mch. Co., Baltimore, Md.
Saginaw Mfg. Co., Saginaw, Mich.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Wood's, T. B., Sons Co., Chambersburg, Pa.

Pumps.
Buffalo Forge Co., Buffalo, N. Y.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.

Punches and Dies.
Armstrong-Blum Mfg. Co., Chicago, Ill.
Bliss, E. W., Co., Brooklyn, N. Y.
Burke Mchy. Co., Cleveland, O.
Cleveland Crane & Engr. Co., Wickliffe, Ohio.
Globe Mch. & Stamping Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Richards, I. P., Providence, R. I.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Watson-Stillman Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Punching and Shearing Machinery.
Bertsch & Co., Cambridge City, Ind.
Bliss, E. W., Co., Brooklyn, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Cincinnati Punch & Shear Co., Cincinnati, O.
Cleveland Crane & Engr. Co., Wickliffe, Ohio.
Long & Allstatter Co., Hamilton, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Royersford Foundry & Mch. Co., Royersford, Pa.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Rapping Plates.
Milwaukee Fdry. Supply Co., Milwaukee, Wis.

Classified Index to Advts. (Continued).

Reamers.
Cleveland Twist Drill Co., Cleveland, O.
Kelly Tool Co., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Works, Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Van Dorn Elec. & Mfg. Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Reamers, Adjustable.
Cleveland Twist Drill Co., Cleveland, O.
Kelly Tool Co., Cleveland, O.
Lapointe Machine Tool Co., Hudson, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Works, Gloucester City, N. J.
Schellenbach-Hunt Tool Co., Cincinnati, O.

Reamers, Pneumatic.
Stow Flexible Shaft Co., Philadelphia, Pa.

Rivet and Spike Machinery.
National Mchy. Co., Tiffin, O.

Riveters.
Buffalo Forge Co., Buffalo, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Grant Mfg. & Mch. Co., Bridgeport, Conn.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Shepard Elec. Crane & Hoist Co., Montour Falls.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.

Roller Bearings.
Bantam Anti-Friction Co., Bantam, Conn.

Rope Dressing and Preservative.
Cling-Surface Co., Buffalo, N. Y.

Saw Blades.
Boker, Hermann & Co., New York.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Hammacher, Schlemmer & Co., New York.
Millers Falls Co., New York.
Simonds Mfg. Co., Fitchburg, Mass.
West Haven Mfg. Co., New Haven, Conn.

Saw Tables.
Crescent Mch. Co., Leetonia, Ohio.

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Billings & Spencer Co., Hartford, Conn.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Espen-Lucas Mch. Wks., Philadelphia, Pa.
Millers Falls Co., New York.
Racine Gas Engine Co., Racine, Wis.
Robertson Drill & Tool Co., Buffalo, N. Y.
Story, H. T., Chicago, Ill.
Tabor Mfg. Co., Philadelphia, Pa.
West Haven Mfg. Co., New Haven, Conn.

Saws, Band.
Crescent Mch. Co., Leetonia, O.
Fox Mch. Co., Grand Rapids, Mich.
Huther Bros. Saw Mfg. Co., Rochester, N. Y.
West Haven Mfg. Co., New Haven, Conn.

Schools.
American School of Corr., Chicago, Ill.
International Corr. School, Scranton, Pa.

Screws and Worms.
Screw Cutting Co. of America, Philadelphia, Pa.

Screw Driver, Automatic.
Reynolds Mchy. Co., Moline, Ill.

Screw Machinery.
Cook, Asa S., Co., Hartford, Conn.

Screw Machines.
Cleveland Auto. Mch. Co., Cleveland, O.
Garvin Mch. Co., New York.
National Acme Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Smurr & Kamen Mch. Co., Chicago, Ill.
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Warner & Swasey Co., Cleveland, O.
Wood Turret Mch. Co., Terre Haute, Ind.

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National Separator & Mch. Co., Boston, Mass.

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Wood's, T. B., Sons Co., Chambersburg, Pa.

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Cincinnati Shaper Co., Cincinnati, O.
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Flather, Mark, Planer Co., Nashua, N. H.
Fox Mch. Co., Grand Rapids, Mich.
Gould & Eberhardt, Newark, N. J.
Hamilton Mch. Tool Co., Hamilton, O.
Hendey Mch. Co., Torrington, Conn.
Juengst, Geo., & Sons, Croton Falls, N. Y.
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New Haven Mfg. Co., New Haven, Conn.
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Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Smith & Mills, Cincinnati, O.
Springfield Mch. Tool Co., Springfield, O.
Steptoe, John, Shaper Co., Cincinnati, O.
Stockbridge Mch. Co., Worcester, Mass.
Walcott & Wood Mch. Tool Co., Jackson, Mich.

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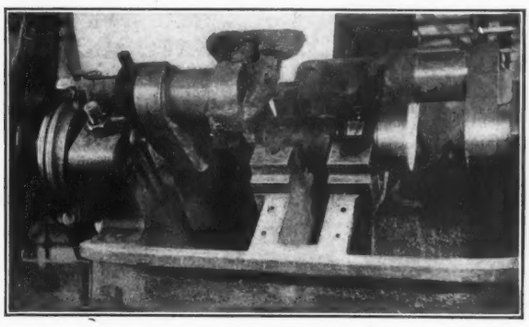
Dill, T. C., Mch. Co., Philadelphia, Pa.
Garvin Mch. Co., New York.
Newton Mch. Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.

Special Machinery.
Blanchard Mch. Co., Boston, Mass.
Bliss, E. W., Co., Brooklyn, N. Y.
Dexter, Chas. S., Attleboro, Mass.
Elgin Tool Works, Elgin, Ill.
Garvin Mch. Co., New York.
Newark Gear Cutting Mch. Co., Newark, N. J.
Niles-Bement-Pond Co., New York.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Waltham Mch. Wks., Waltham, Mass.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Williams, White & Co., Moline, Ill.
Wilson, W. A., Mch. Co., Rochester, N. Y.



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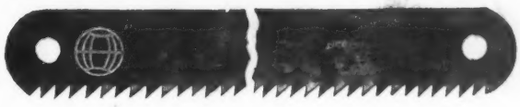

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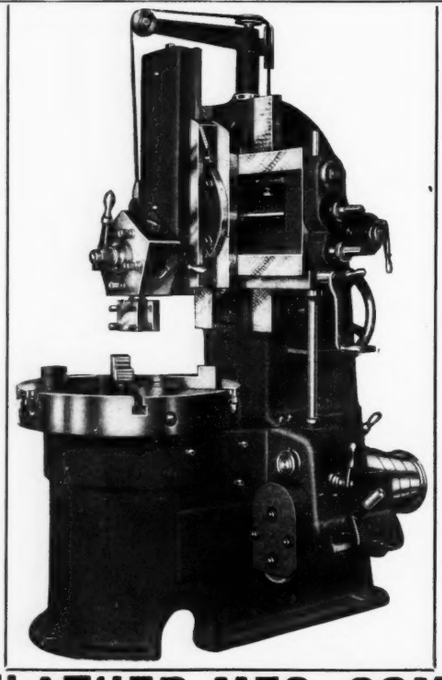

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Nash, Geo., Co., New York.
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Lufkin Rule Co., Saginaw, Mich.
Starrett, L. S., Co., Athol, Mass.

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Lyon Metallic Mfg. Co., Aurora, Ill.

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Waltham Mch. Wks., Waltham, Mass.

Swaging Machines.
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Taps and Dies.
Bay State Tap & Die Co., Mansfield, Mass.
Besly, C. H., & Co., Chicago, Ill.
Butterfield & Co., Derby Line, Vt.
Card, S. W., Mfg. Co., Mansfield, Mass.
Carpenter, J. M., Tap & Die Co., Pawtucket, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Hart Mfg. Co., Cleveland, O.
Jessop, Wm., & Sons, Ltd., New York.
Lapointe Machine Tool Co., Hudson, Mass.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford.
Pratt & Whitney Co., Hartford, Conn.
Reece, E. F., Co., Greenfield, Mass.
Reed Mfg. Co., Erie, Pa.
Smart, A. J., Mfg. Co., Greenfield, Mass.
Standard Tool Co., Cleveland, O.
Toledo Mch. & Tool Co., Toledo, O.
Wells Bros. Co., Greenfield, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Tapping Attachments.
Beaman & Smith Co., Providence, R. I.
Cincinnati Mch. Tool Co., Cincinnati, O.
Modern Tool Co., Erie, Pa.
Rockford Drilling Mch. Co., Rockford, Ill.

Tapping Machines.
Baker Bros., Toledo, O.
Burke Mchy. Co., Cleveland, O.
Garvin Mch. Co., New York.
Murchey Mch. & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Saunders', D., Sons, Yonkers, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.

Thermit.
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Automatic Mch. Co., Bridgeport, Conn.
Bickford & Washburn, Greenfield, Mass.
Billings & Spencer Co., Hartford, Conn.
Fay Mch. Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe Mfg. Co., Brighton, Mass.

Tire Welders and Benders.
Buffalo Forge Co., Buffalo, N. Y.
Williams, White & Co., Moline, Ill.

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Montgomery & Co., New York.
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Beaman & Smith Co., Providence, R. I.
Billings & Spencer Co., Hartford, Conn.
Krieger Tool & Mfg. Co., Grand Rapids, Mich.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Tool Racks.
Lyon Metallic Mfg. Co., Aurora, Ill.
New Britain Mch. Co., New Britain, Conn.

Tracks, Trolley and Overhead.
Yale & Towne Mfg. Co., New York.

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General Elec. Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Transmission Machinery.
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Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Wood's, T. B., Sons Co., Chambersburg, Pa.

Trimmers, Wood.
Fox Mch. Co., Grand Rapids, Mich.

Trolleys.
Yale & Towne Mfg. Co., New York.

Tube Expanders.
Watson-Stillman Co., New York.

Tubing, Seamless Steel.
Cumberland Steel Co., Cumberland, Md.
National Tube Co., Pittsburg, Pa.
Standard Welding Co., Cleveland, O.

Tumbling Barrels.
Globe Mch. & Stamping Co., Cleveland, O.

Classified Index to Advts. (Continued).

Turret Machinery.
Bullard Mch. Tool Co., Bridgeport, Conn.
Fay & Scott, Dexter, Me.
Flather, E. J., Mfg. Co., Nashua, N. H.
Gisholt Mch. Co., Madison, Wis.
Hendey Mch. Co., Torrington, Conn.
International Mch. Tool Co., Indianapolis, Ind.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice, Geo. G., & Co., New Haven, Conn.
Smurr & Kamen Mch. Co., Chicago, Ill.
Steinle Turret Mch. Co., Madison, Wis.
Warner & Swasey Co., Cleveland, O.
Windsor Mch. Co., Windsor, Vt.

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Baush Mch. Tool Co., Springfield, Mass.
Boston Gear Wks., Norfolk Downs, Mass.

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National Tube Co., Pittsburg, Pa.

Vises.
Armstrong Mfg. Co., Bridgeport, Conn.
Graham Mfg. Co., Providence, R. I.
Merrill Bros., Brooklyn, N. Y.
Plunket, J. E., Chicago, Ill.
Prentiss Vise Co., New York.
Reed Mfg. Co., Erie, Pa.
Skinner Chuck Co., New Britain, Conn.
Williams, J. H., & Co., Brooklyn, N. Y.
Wyman & Gordon, Worcester, Mass.

Welding.
Davis-Bournonville Co., New York.
Goldschmidt Thermit Co., New York.
Standard Welding Co., Cleveland, O.

Wire Nail and Washer Mchy.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.

Wood Working Machinery.
Crescent Mch. Co., Leetonia, O.
Fox Mch. Co., Grand Rapids, Mich.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Wrenches.
Armstrong Mfg. Co., Bridgeport, Conn.
Bemis & Call, H. & T., Co., Springfield, Mass.
Billings & Spencer Co., Hartford, Conn.
Carpenter, J. M., Tap & Die Co., Pawtucket, R. I.
Coes Wrench Co., Worcester, Mass.
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Trimont Mfg. Co., Roxbury, Mass.
Walworth Mfg. Co., Boston, Mass.
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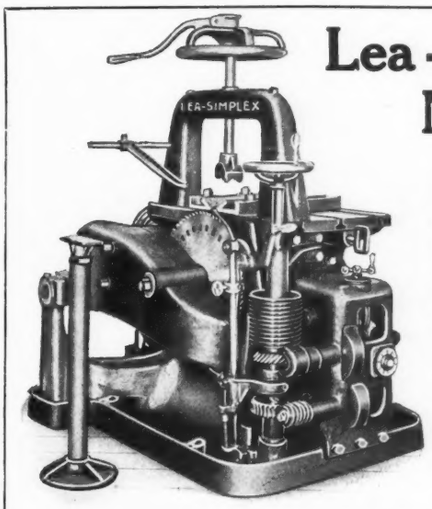

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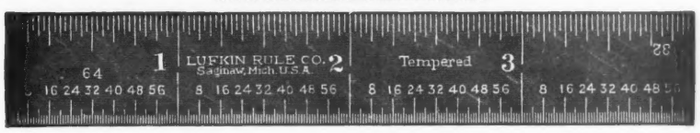

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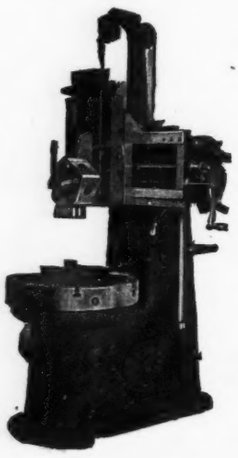

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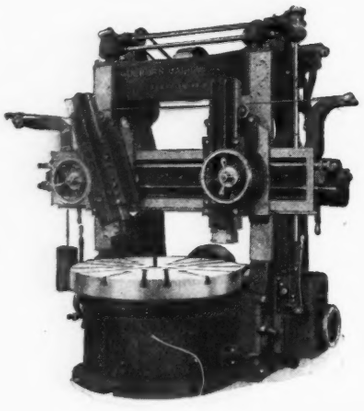

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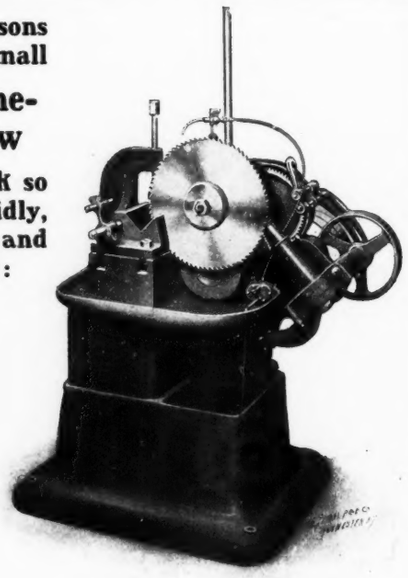

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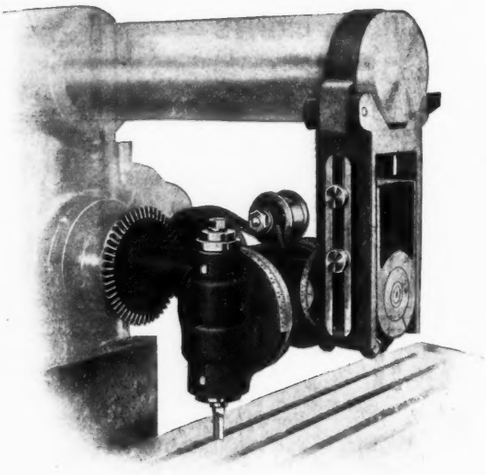
FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry, England, for Great Britain, France, Italy, Holland, Belgium Switzerland, Spain and Portugal.

High Speed and Sensitiveness are the 20th Century Features of this Full Universal Milling Attachment



Designed for use on any size or make of milling machine. Maximum speed 2500 to 3000 R.P.M.

Send for descriptive circular and list of users.

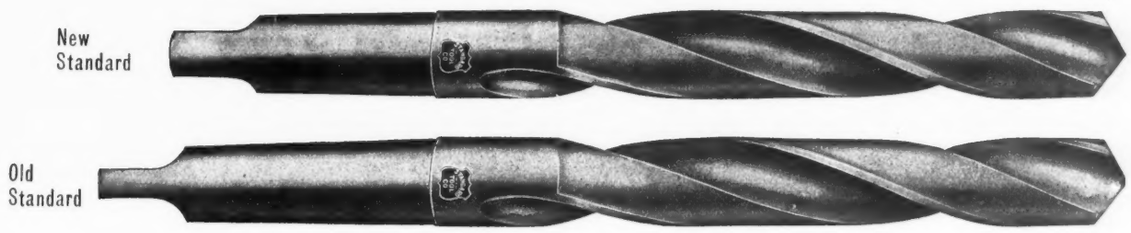
THE PORTER-CABLE MACHINE CO.

105 Canal St., SYRACUSE, N. Y., U.S.A.

A NEW STANDARD

The "STANTOOL"

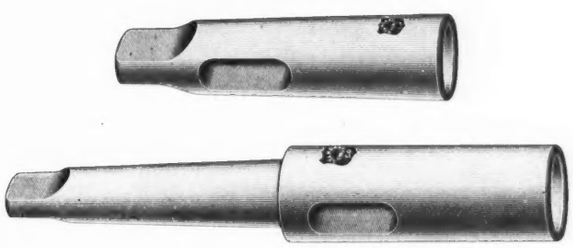
Short Taper Shank with Heavy Tang



Modern methods of drilling demand a stronger construction of shank and tang than the old standard. To meet this we offer our new "Stantool" shank. The new tang has much greater strength, offers a positive drive and overcomes the breakage, which has been a serious difficulty heretofore.

Drills with "Stantool" shank cost no more. Offer Greater Strength. Are More Durable. Overcome Tang Breakage.

"Stantool" Sockets and Sleeves



For use in connection with "Stantool," short shank drills are made in all sizes and will fit the taper spindles of all makes of drill presses.

THE STANDARD TOOL CO.

OFFICE AND FACTORY:
Cleveland, Ohio, U.S.A.

London, C. W. Burton, Griffiths & Co. Burton, Fils, Paris.
F. W. Horne, Yokohama, Japan.

STANDARD TOOL CO.

EASTERN SALESROOM:
94 Reade St., New York

J. Lambercier and Cie, Geneve. Wilh. Sonesson & Co., Malmo, Sweden. Honore Demoor & Co., Bruxelles.

The Outside of our

Will make anybody who takes even the smallest

And the promise of the cover is fully justified in the pages it encloses. We have put a lot of thought, and work, and care, and information into the make-up of our book. We feel that it is different--a long way different--from the general run of machine tool catalogues; it is 114 pages of good sound meat, without the padding of high-flown words and rounded periods. It is of a progressive nature, covering the Cleveland Automatics from A to Z--starts with the factory and winds up with a few simple instructions for placing orders.

The illustrations speak for themselves, the text is almost super-

Cleveland Automatic Machine

Eastern Representative—J. B. Anderson, 2450 No. 30th St., Philadelphia. Western Representative H. E. Nunn, 67 W.
castle-on-Tyne and Glasgow. Messrs. Schuchardt &Schutte, Vienna, Berlin, St. Petersburg, Stockholm,

The Pre-eminence of the

New Catalogue

interest in Screw Machines want to see the inside

fluous, the different machines are shown from every view point, in every size, and every style. A study of the various tools employed is in itself an education. A formula for making circular tools is one of the interesting features, and a sheaf of valuable data is gathered into the last few pages.

Altogether it is a catalogue you need, and which we shall be glad to send you. Specify the Red Catalogue and send your address early.

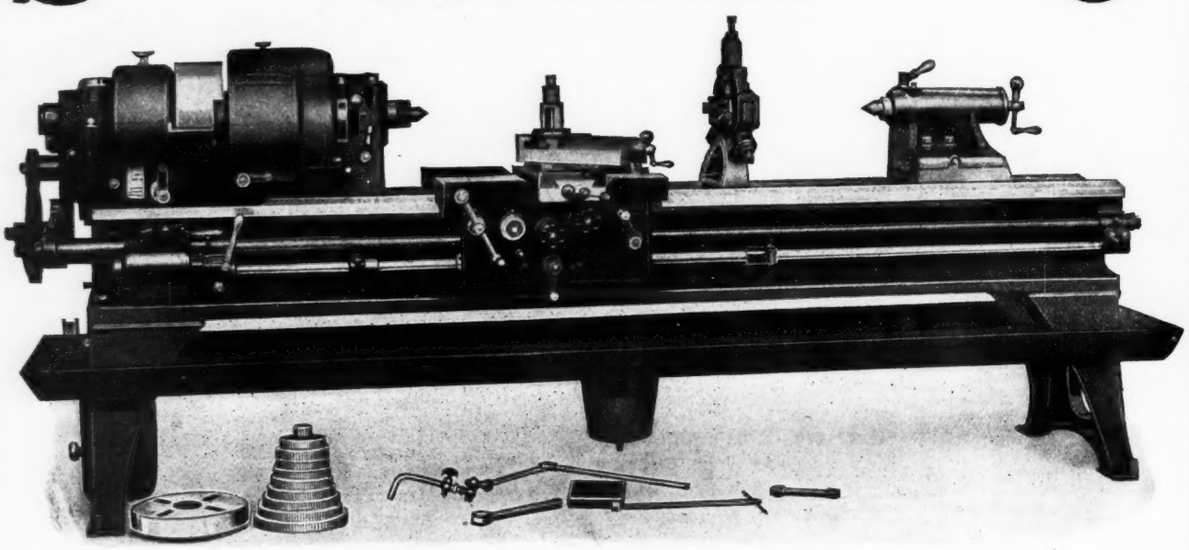
The several features of this catalogue will be advertised in this space month by month. Don't miss a chapter in the serial—look for continuation of the story in July.

Company, Cleveland, O., U.S.A.

Washington St., Chicago. Foreign Representatives—Chas. Churchill & Co., London, Manchester, Birmingham, New-Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milano and Bilbao.

"Cleveland" is Indisputable

SPRINGFIELD ECONOMY

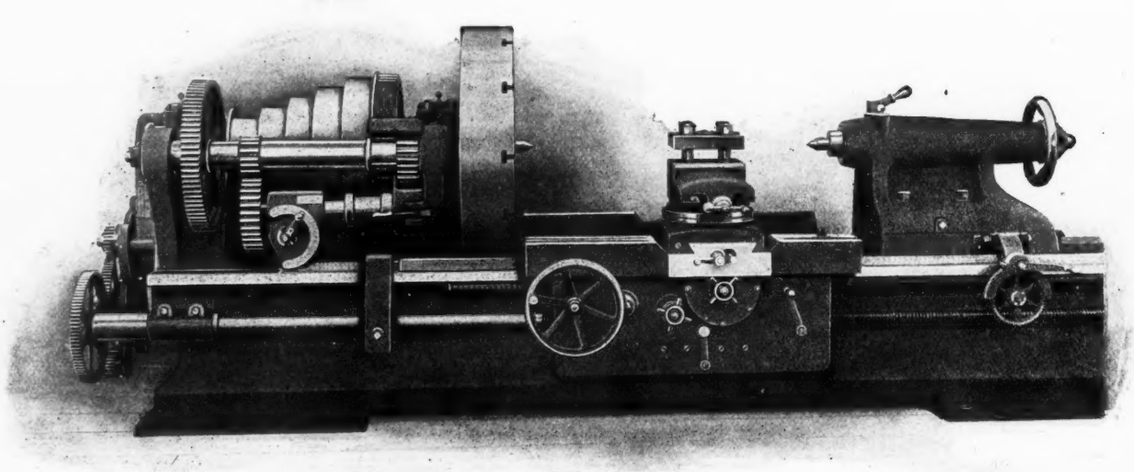


No. 3 High Power Rapid Reduction Lathe, with 20 speeds.
The highest type of high speed lathe—Strong, rigid, accurate. Six variations of feed under instant control of operator.

When times are bad and money tight and the tariff unsettled, cost cutting machines are particularly important. Springfield Machine Tools are noted for their cost reducing features, large output, accuracy, power and long service qualities.

We build our machines from the foundry up, put them through in large lots and can therefore insure the best in design and workmanship at the closest price.

Ask for circulars of our high grade Tools.

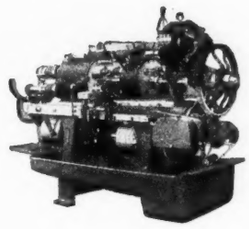


Springfield 36-inch Triple Geared Engine Lathe.

THE SPRINGFIELD MACHINE TOOL COMPANY

631 SOUTHERN AVENUE, SPRINGFIELD, OHIO, U. S. A.

Agents for Chicago, McDowell, Stocker & Co. Agents for Italy, Ercole Vaghi, Milan. Agents for Germany, L. Loewe & Co., Berlin.



COST of manufacturing Screws and other products of the Screw Machine, has been decidedly decreased twice in about ten years.

¶ Single Drive-Belt or Motor-superseding Multiple Belts, reduced the expense by eliminating or largely decreasing belting troubles, and preventing breakage of Tools and parts by the use of Safety Clutches, which in emergency, free the Tools from the Drive automatically,—production being increased by the more continuous and effective use of the Machine.

¶ The medium for these developments has been the **Acme Automatic Multiple Spindle Screw Machine.**

THE NATIONAL-ACME MANUFACTURING CO.

CLEVELAND, OHIO

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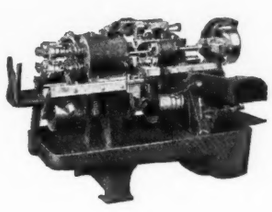
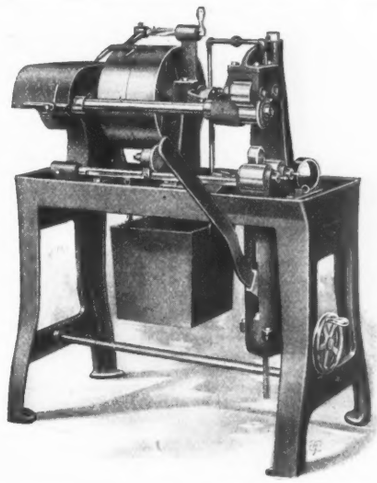
GENERAL FOREIGN REPRESENTATIVES
ALFRED H. SCHUTTE—SCHUCHARDT & SCHUTTE





DON'T BUY PIPE

Cut to short lengths

Cut it yourself. **Fox Power Pipe or Tube cutters.** Better. Cheaper. Machine above cuts 4 inch pipe, 18 seconds. 2 inch, 9 seconds. Good job, too.

Smaller machines for smaller sizes.

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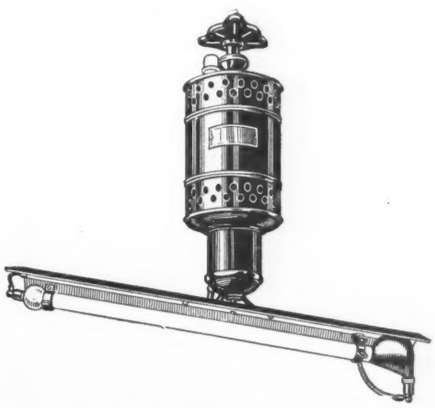
FOX MACHINE CO. 815-825 No. Front St. GRAND RAPIDS, MICH.

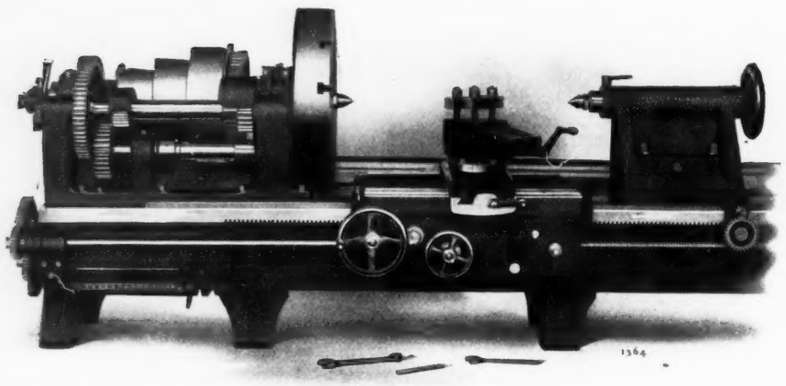
Cooper Hewitt Lamps



You cannot expect good work with poor light

You can have better light in your shops by installing Cooper Hewitt Lamps, and your mechanics will do better work than by any other light. This may seem a strong statement but it is based upon actual experience. Cooper Hewitt Light is steady and unvarying, easier and less trying to work under than any other light. We have a pamphlet No. 90 "Industrial Plant Illumination" which goes fully into the matter; send for a copy.

Cooper Hewitt Electric Co.
220 West 29th St., New York



36-in. Pond Engine Lathe—Cone has three wide steps.

Heaviest Cuts

with modern high-power tools made possible by the great weight and stiffness of Pond Lathes

Quick change gear mechanism is very strong and simple, and is operated by a single handle. All gears have wide faces and are of large pitch.

Tool does not overhang bed when turning largest diameters.

Self-oiling bearings—Hammered steel spindles—Steel feed rack—Bronze lined bearings.

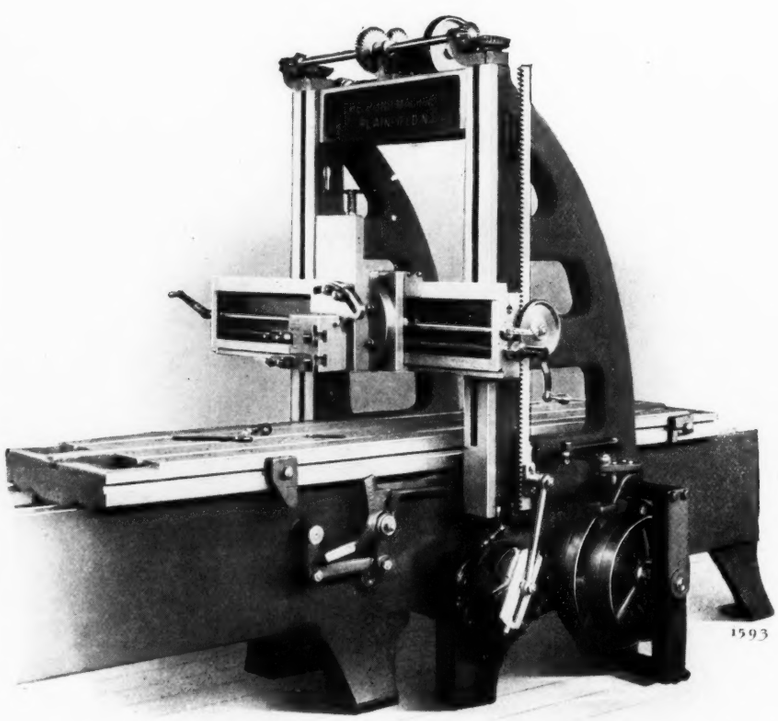
Write for Catalog "Pond Lathes" mentioning sizes.

Planing Machines

We build a great variety of types of planing machines for all classes of work, from die work up to the extremely heavy special planers for armor plate work.

The standard types are regularly built from 17 inches to 14 feet between housings while the special machines vary in size for the different classes of work for which they are specially designed.

Write for Catalog "Pond Planers."

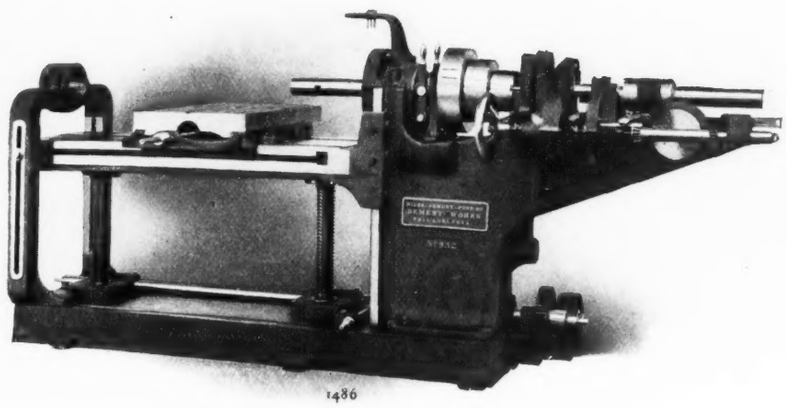


32-in. Pond Planer.

NILES ELECTRIC

NILES-BEMENT-POND COMPANY

OFFICES—Boston, Oliver Bldg. Chicago, Commercial National Bank Bldg. Pittsburgh, Frick Bldg. St. Louis, 516 No. Third St. Philadelphia, 21st and Callowhill Sts. Birmingham, Ala., Brown-Marx Bldg. Agents for Canada, The Canadian Fairbanks Co., Ltd., Montreal, St. John, Toronto, Calgary



60-in. (3⅛ in. spindle) Horizontal Boring and Drilling Machine.

Irregular Pieces

which are difficult to hold are economically handled on these machines, as a number of holes may be drilled and bored at one setting

We build several sizes of Horizontal Boring and Drilling Machines with spindles of from 2½ to 6 inches diameter.

Tables are adjustable for height longitudinally and crosswise. Point of operation always remains at a convenient height from the floor. Tables have both power and hand lift.

Hand vertical adjustment, all feed changes, rapid and slow hand-traverse, feed throw-out, feed screws and back gear to drive, operated from one convenient position.

Write for Catalog "Horizontal Boring and Drilling Machines."

Steam or Air

may be used to operate Bement Hammers.

Single and Double Frame
Single and Double Open Frame
Board and Steam Drop
Double Frame Steel Tilting
250 to 40,000 lbs. Falling weight

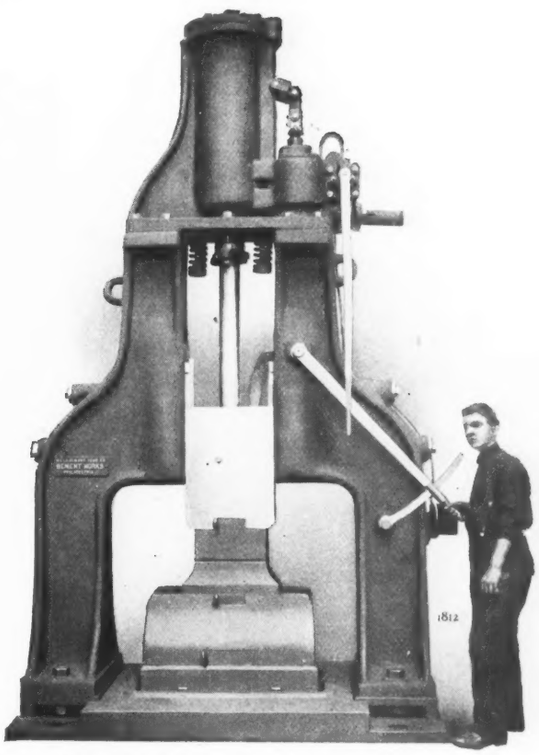
Dies are cast steel, from a special mixture, and piston rods are nickel steel.

Rams and guides are forged steel, the latter with carbon somewhat different from the former to prevent cutting.

Foundations are simple and inexpensive.

All hammers tested with steam before leaving our works.

Write for complete Catalog "Bement Hammers."



1500-lb. Double Frame Bement Hammer.

TRAVELING CRANES

111 Broadway, New York, 25 Victoria St., London

and Vancouver. Agents for California, Nevada and Arizona, Harron, Rickard & McCone, 461 Market St. San Francisco, and 164-168 N. Los Angeles St., Los Angeles, Cal. Italy, Ing. Ercole Vaghi, Milan. Germany, F. G. Kretschmer & Co., Frankfurt, a. M. Japan, F. W. Horne, 70-C Yokohama.

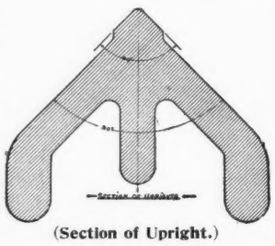
THE NEW

DROP HAMMER

The B. & S. Model "C"

¶ It has undergone the severest tests in our own drop shop and we unhesitatingly recommend it for yours.

¶ An improved board clamp is located at the extreme top of the machine, where it is impossible for oil to get between the clamps and board. The front and rear friction rolls with their eccentrics are interchangeable, and are so adjusted that a true alignment between the lifting board and rolls is always preserved. The special bronze bearings are easily removed and replaced. All adjustments are made from the floor. Other important improvements.



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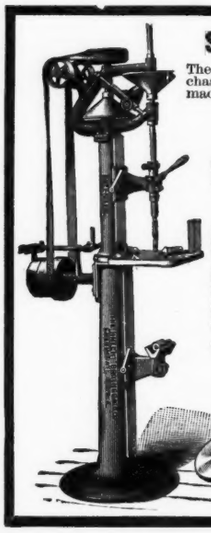
Full details and prices gladly sent on request.

THE BILLINGS & SPENCER CO.
HARTFORD, CONN.
London, 8 Long Lane, Aldersgate Street.



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The natural result of the purchase of modern high-class machine tools.

KNECHT-FRICTION SENSITIVE DRILLS

give satisfaction from the moment they begin their work

Because They Are

unsurpassed in material and workmanship. Compact and rigid in design. Accurate and convenient in operation. With such a machine properly used, you cannot help saving money. Booklet yours for the asking.

The KNECHT BROS. CO.
819 Wade Street,
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Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, R. S. Stokvis & Zonen, Agents for Holland and the Dutch East Indies.

PUT BACK IN THE TOOL-ROOM what you wear off in the Shop!

"Ask the man who uses them."

That is exactly what you can do with PARADOX ADJUSTABLE REAMERS—"Adjustable in the Tool-Room, but Solid in the Shop."

THINK:—It means an end to the waste and annoyance of that scrap-heap of undersize reamers. Think of the saving in tool expense.

When the "Paradox" has done the work of nine or ten old-style solid reamers you will need new blades. But the old blades are all you have to scrap. They are inexpensive—the bodies last for years, Prove it for yourself! (*See page 31.*)

THE CLEVELAND TWIST DRILL CO., Cleveland, Ohio.

COES WRENCHES

Steel Always Reliable

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COES WRENCH CO., Worcester, Mass.

Or, J. H. Graham & Co., J. C. McCarty & Co., New York.

Automatic and Special Machinery

of all kinds designed and built. Inventions perfected. Builders of Variable Speed Iron Planers. Correspondence Solicited.

ENGINEERS AND MACHINISTS.
The W. A. Wilson Machine Co.
ROCHESTER, NEW YORK.

Bench Machine, No. 81.

SPEED IS AN OBJECT

in all kinds of manufacturing--let us help you save time on your riveting.

The Grant Rotary Rivet Spinning Machine

will put a head on a rivet in **one second.** The work is done accurately, noiselessly and without danger of bruised plates or bent shanks. Soft brass rivets are as readily handled as hard steel; change from one size or shape rivet to another can be made in a few minutes, and the range of work is the widest.

No springs to break, no parts to crystallize and no nerve racking noise. Ask for the book.

The Grant Mfg. and Machine Co.
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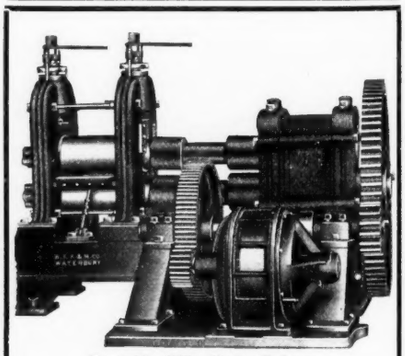

Portable Mill—Motor Driven.

ROLLING MILLS

For Rolling: BRASS, COPPER, STEEL, SILVER, TIN FOIL, ETC.

IN SHEETS AND RODS

Send for Catalogue "R."

The Waterbury Farrel Foundry & Machine Company

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Western Office: Cleveland, Ohio, 1012 Williamson Bldg.

MORSE DRILLS!

And it's all in the name, but it has taken years of time and unceasing effort to put it there.

Every drill user knows that "Morse" on a drill means an absolute guarantee against defects, that the drill is accurate as to size, is right in shape and temper and is fully guaranteed to do the work, unless abused. All kinds, for all purposes.

ASK FOR SPECIAL CATALOGUE No. 2636

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

NEW YORK, SINCE 1848

4th Ave. and 13th St.

The New High Speed Steel

NOVO SUPERIOR

THE LATEST INVENTION IN METALLURGY

Is now in stock in our Warehouses in all current sizes, flats, squares and rounds, annealed and unannealed.

It is claimed, for **NOVO SUPERIOR STEEL** that according to conditions, the speed can be increased over the present high speed steels, and sometimes 25, 50 and even 100 per cent. more speed has been obtained and the cutting edge has retained its sharpness from **four to six times longer** than on other high speed steels.

It cuts **harder material** than has heretofore been considered possible. Namely, steel castings, with vitrified sand blowholes, skidded tires, exceptionally hard and partly chilled cast iron.

It is **tougher than other high speed steel.** Therefore particularly adapted for tools that must stand a severe blow or pressure.

It is invaluable for automatic screw machine work where a **very fine cutting** edge is necessary.

Novo Superior steel is suitable for milling cutters, formed cutters, gear cutters, reamers, etc. Will wear from four to six times longer than other steels.

Novo Superior steel hardens in oil or water.

Send us a trial order. We guarantee results.

HERMANN BOKER & COMPANY

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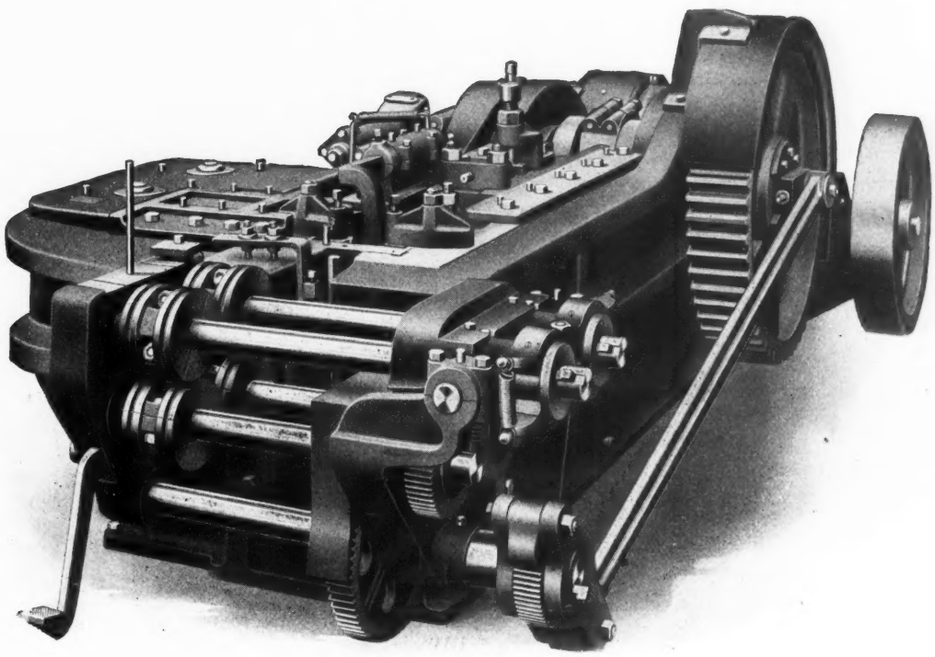
AJAX

Automatic Feed Rivet Heading Machine



For the Economical Manufacture of Rivets

The highest type of its class, this machine will almost double production over the ordinary hand fed machines and is indispensable where rivet work is handled in quantities. Rivet bars in mill lengths are heated in long furnaces, and are then fed into the machine, which makes the entire bar into rivets, one at each revolution, without further handling, and with a practical elimination of the loss from stub ends. These machines are strong, rigid, with all wearing parts lined or bushed, are made in four sizes, 1″, 1 ¼″, 1 ½″ and 1 ¾″, and belt or motor driven as desired.

We shall be glad to furnish further particulars and to send catalogue of our full line of Forging Machinery.

THE AJAX MANUFACTURING COMPANY

CLEVELAND, OHIO

New York: Hudson Terminal Building, 50 Church Street **Chicago: 621 Marquette Building**

de Fries & Co., Dusseldorf, Germany

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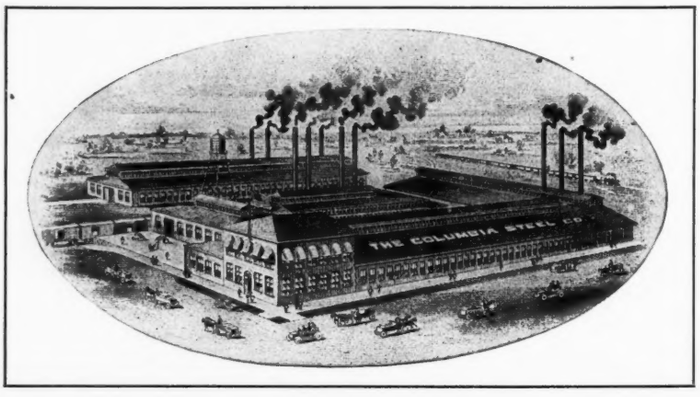

COLD ROLLED STEEL STRIPS AND SHEETS

Ribbon steel down to .003".

Highly finished narrow bars with sheared or rolled edges.

Special deep drawing stock with extra finish for nickel plating.

Cold rolled bars to 3/8" thick.

Sheets to 16" wide.

Automobile frame steels; sheared to irregular shapes if wanted.

THE COLUMBIA STEEL COMPANY, ELYRIA, OHIO

TRADE MARK

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CAPITAL

THIS MARVELOUS

WATER-HARDENING HIGH-SPEED STEEL

Lasts Longer and Cuts Cleaner than Standard High-Speed Steels.
May be hardened in oil or air blast if preferred.

UNEQUALED FOR MILLING CUTTERS, TWIST AND FLAT DRILLS, ETC.

Supplied PATENT ANNEALED to turn and mill easily.
Simple Hardening Treatment.

You have seen announcements of a wonderful Steel discovery in the Press

ULTRA CAPITAL IS A STEP FURTHER

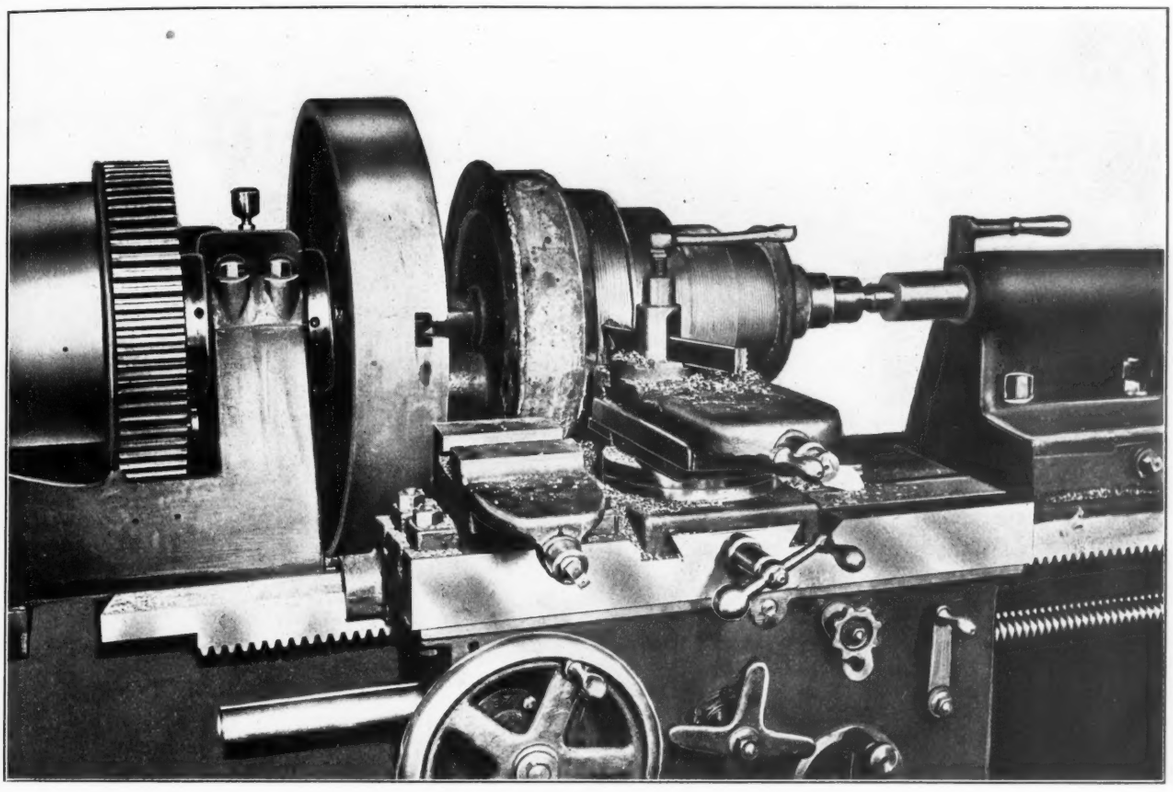
Quick Delivery. Expert if Desired.

GEO. NASH CO.

CHICAGO PHILADELPHIA NEW YORK

"BLUE CHIP" STEEL

MAKING NEW RECORDS



A "BLUE CHIP" TOOL ON A 24" NEW HAVEN DOUBLE BACK GEARED LATHE

Rough Turning 5 Step Cone Pulley—

Steps 7" to 16" dia. x 3 3-8" face.
Cutting speed, 120 to 205 feet per minute.
Feed, 1-8". Reduction in diameter, 1-4".
Time, to rough turn 5 steps with sides and flanges, 12 minutes.

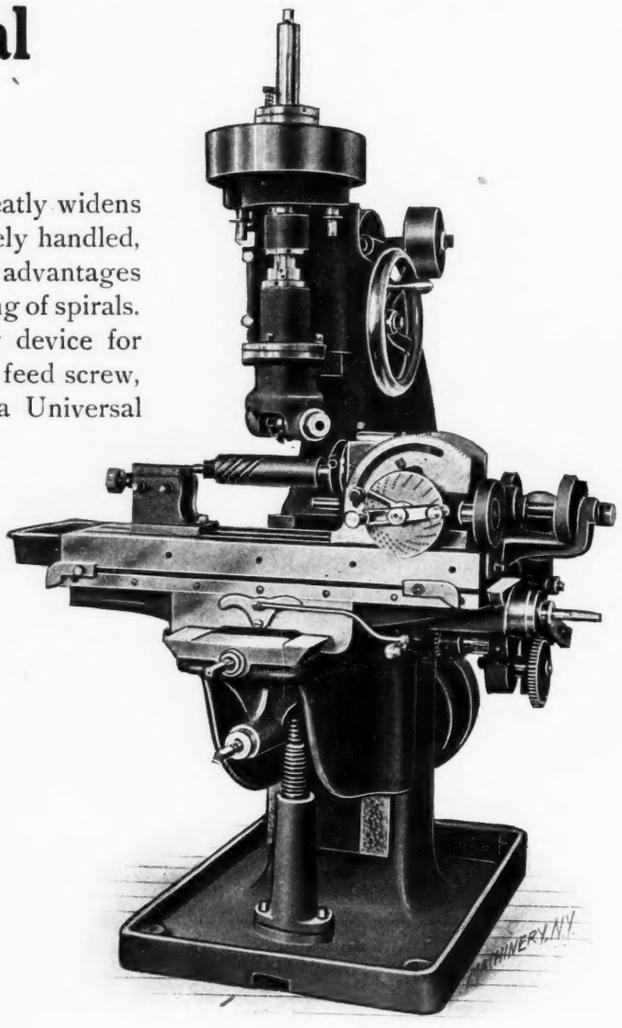
Reasons Why:—Behind "Blue Chip" Steel you have our experience in its making, and care in selecting the exact grade for your particular need. Our man will be on your job at your request.

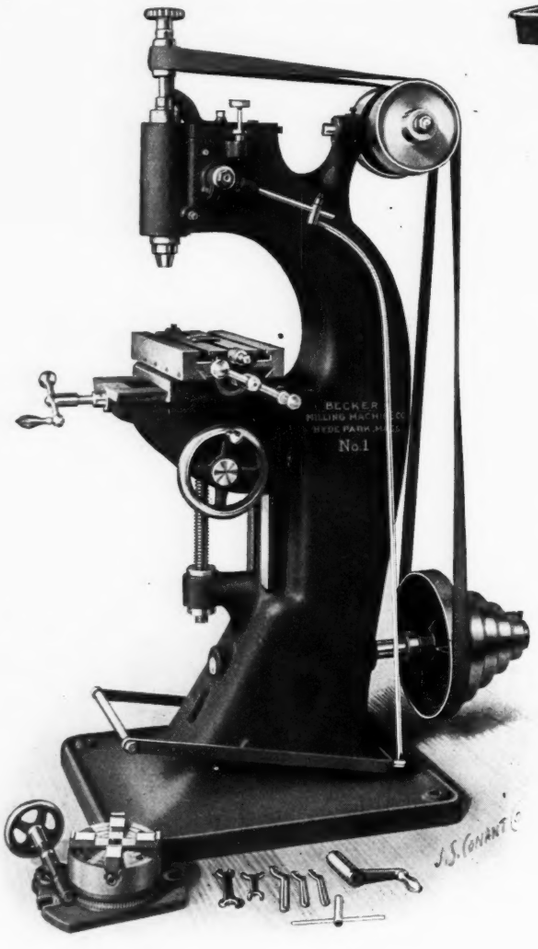
FIRTH STERLING STEEL COMPANY

McKeesport, Pa. New York Boston Philadelphia Chicago San Francisco

The New Horizontal Milling Attachment for Becker Vertical Milling Machines

is an important improvement which greatly widens the range of work which can be effectively handled, and gives the vertical machine all the advantages of the horizontal type, including the cutting of spirals. A further advantage is a supplementary device for connecting the spiral head to the table feed screw, which practically converts the tool into a Universal Milling Machine. Ask us for detailed description, also for circular of the





Becker Milling Machine No. 1

A tool which is particularly adapted for all classes of light milling on wood or metal. Is very economical, capable of speed ranging from 2,000 to 10,000 revolutions per minute, and can also be used as a sensitive drill press if desired.

The Becker Milling Machine Co.

HYDE PARK, MASS.

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"OWEN" No. 3 Plain Miller

It is POWERFUL.
It is MASSIVE.

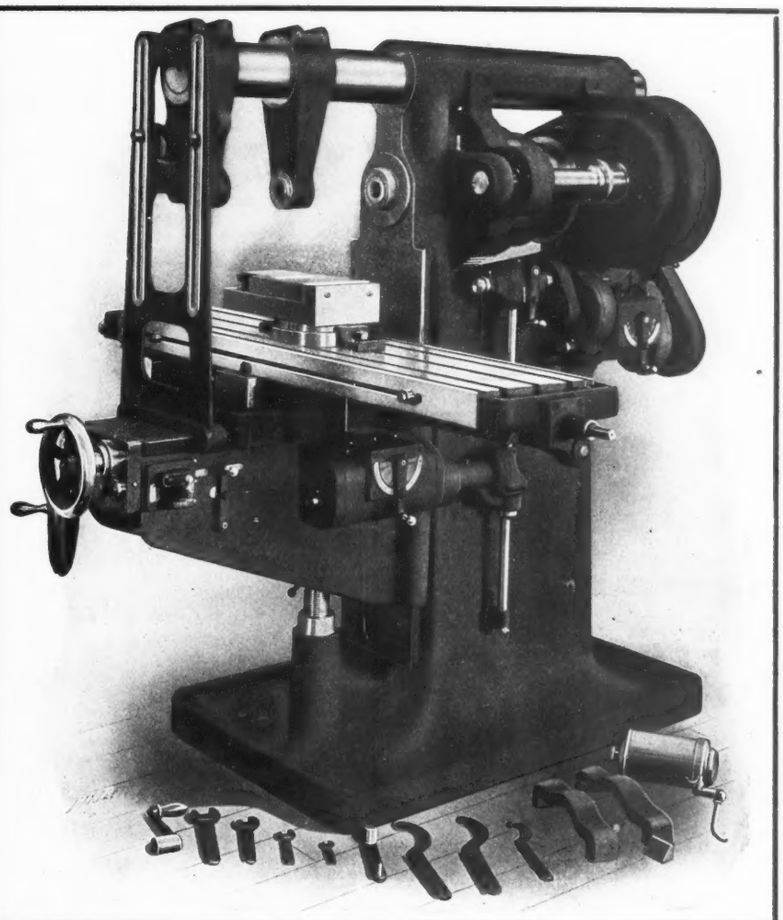
Try one and be convinced.
Ask for full description.

The Owen Machine Tool Company

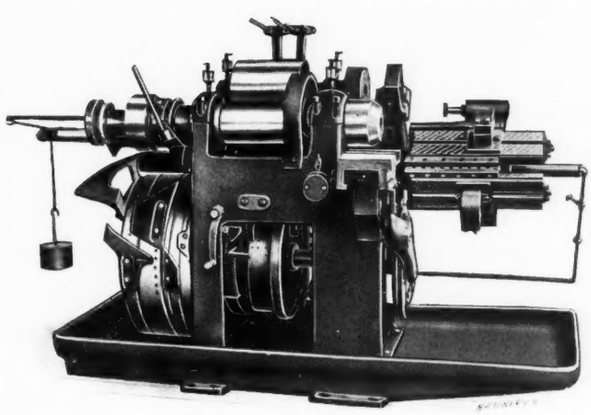
Dept. M, Springfield, Ohio

United States Selling Agents—Chandler & Farquhar Co., Boston, Mass. Vandyck Churchill Co., New York and Philadelphia. Syracuse Supply Co., Syracuse and Buffalo, N.Y. Somers, Fitler & Todd Co., Pittsburg. C. C. Wormer Mchy. Co., Detroit. Patterson Tool & Supply Co., Dayton, O. and Indianapolis, Ind. Wallis Engineering Co., Columbus, O. B. A. Tozzer, 2344 Prospect Avenue, Cleveland, O. O. L. Packard Mchy. Co., Chicago and Milwaukee. English Tool & Supply Co., Kansas City, Mo. Fairbanks Co., New Orleans.

Foreign Agents—Alfred Herbert, Ltd., Coventry, Eng. De Fries & Co., Akt. Ges., Dusseldorf, Berlin and Stuttgart, Germany; Milan, Italy; Barcelona, Spain. Louis Besse, Paris, France. Alfred Herbert (France), Ltd., for Belgium and Switzerland. Alfred Herbert, Ltd., Yokohama, Japan.



Gridley Automatic Turret Lathes

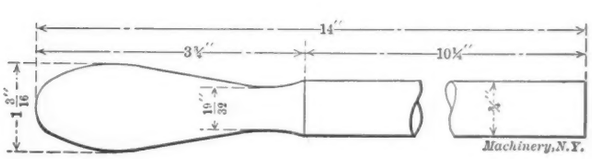


Are wide range machines in every sense. They will handle longer work than any other automatic, have capacity for high speeds, coarse feeds and heavy cuts, are labor saving and very convenient.

The cutting tools do not overhang, an exclusive advantage, and being rigidly held at the cutting point insure accuracy. Output is greatly increased by the method of attaching tools for each operation to independent slides, allowing the use of two or more tools, one back of the other, so that one movement of the tool slide in the turret does the same work that on other turret machines requires two or three movements of the turret.

Example of Rapid Work

Piece—14" long—material cold rolled steel—made on 2⅛" machine. Time to complete all operations **15 minutes.**



ASK FOR NEW CATALOGUE

WINDSOR MACHINE CO., Windsor, Vt.

Manning, Maxwell & Moore, Inc., Sales Agents, New York, Syracuse, Pittsburg, Philadelphia, Cleveland, St. Louis, Milwaukee, Chicago and Birmingham.

TRY THIS BRAND OF FILES

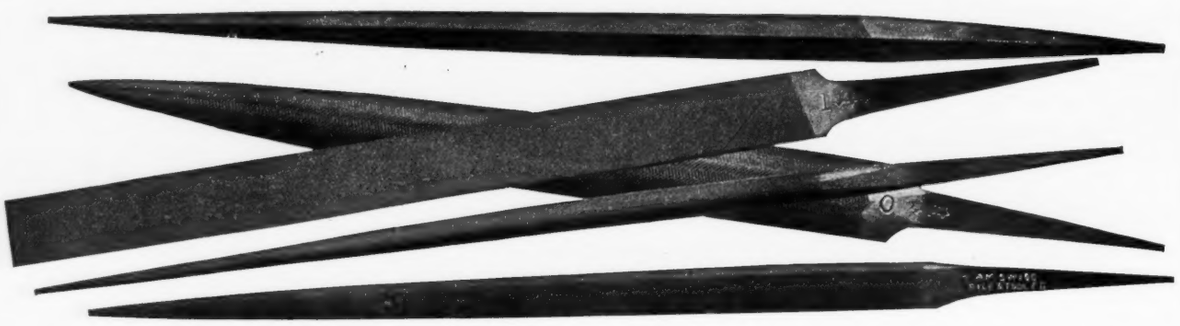
Made for toolmakers' and machinists' use, after the finest Swiss patterns, and from a superior steel which has the toughness so essential for a file and all the qualities which insure durability, a keen cutting edge, and temper for the most delicate work.

Ask for free Sample Files for trial.

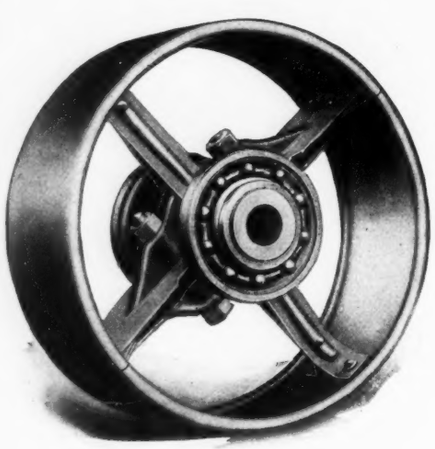
AMERICAN SWISS FILE AND TOOL COMPANY

PRINCIPAL OWNERS AND SELLING AGENTS

E. P. REICHHELM & COMPANY, 24 John St,, NEW YORK



Chapman Double Ball Bearings



If you are tired of wasting time, energy and swear words on your loose pulleys, let us refit them with our Double Ball Bearings.

There is no part of ordinary shop equipment that gives more trouble than the loose pulley, or is more continually out of repair—

Chapman Double Ball Bearings

reduce friction to an almost negligible quantity, keep the pulleys running smoothly and effectively, require no oiling nor other attention and insure a saving of over 100 per cent. on the investment.

Adapted for service wherever friction exists. Ask for the book.

CHAPMAN BALL BEARING COMPANY

40 BRISTOL STREET, BOSTON, MASS., U. S. A.

NEW YORK PHILADELPHIA CHICAGO ST. LOUIS

WE HAVE BEEN MAKING

Cleveland Open Side Planers

FOR THE PAST SEVEN YEARS.

Bed, column, and cross rail of Box Section design.
All gears removable from side except bull gear which lifts out from top.
Rack under table made of semi steel.
All machines have countershaft attached to top of column.
Planers furnished parallel or right angle drive.
Any size from 30" to 60", any length.
Simplicity without sacrificing any movement or convenience, is our aim.
Workmanship and facilities unexcelled.

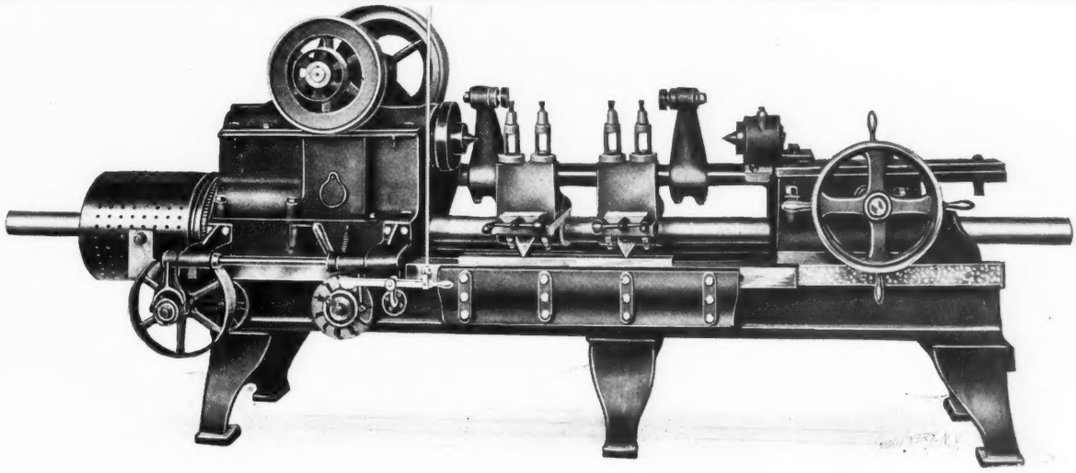
MANUFACTURED BY

The Cleveland Planer Works

JAMES G. DORNBIRER GEO. W. FORD.
3150-3152 Superior Ave.
CLEVELAND, OHIO, U. S. A.

36" x 36"—12-ft. Planer.

Motor Driven.



24-INCH FAY AUTOMATIC LATHE

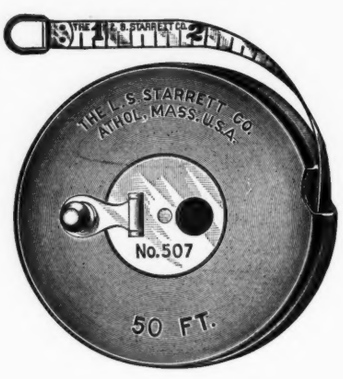
A new size in the Fay line—Swings 24" over the ways, 18" over the carriage, takes 36" between centers and has automatic feed for the carriage of 14". The Fay Automatics are especially adapted for turning operations on castings in large quantities, and are unique among automatic lathes in the fact that they will work on centers. The 24" machine is provided with two carriages and two supplementary tool holders in the rear, fitting it for a great variety of turning and facing work. The main carriage may be used with a former for turning tapers, crowning pulleys, etc., and special provision is made for finishing faces and edges of bevel gears and similar work.

Write for full Description and Examples of Economical Turning

FAY MACHINE TOOL COMPANY, PHILADELPHIA, PA., U.S.A.

Starrett Steel Measuring Tapes

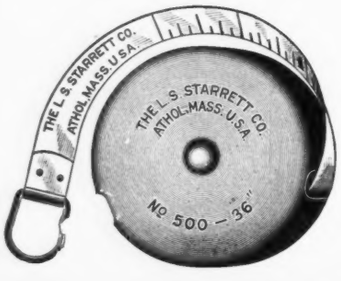
Insure the closest measurements no matter what the length, can be relied on for accuracy, are easily read, and with ordinary care will last a life-time.



Unswerving, unshrinking, unbreakable—a steel tape is the only satisfactory measure for long lengths. The expansion and contraction of a Starrett Tape one hundred feet long is less than a quarter of an inch, with a temperature variation of thirty degrees.

There is hardly a chance for error in reading a Starrett Tape, because of the special marking. The figures placed at each foot are considerably smaller than the intervening figures denoting inches or fractions of a foot, which is an immense improvement over the usual uniformity of marking.

The Push Button Handle Opener is also a Starrett feature—saves time, temper and trouble; no bother to open the handle, a light pressure on the button on the opposite side does the trick—just as easy with your gloves on as off.



Starrett Steel Tapes range in lengths from 3 feet to 100 feet, have a wide variety of graduations, are put up in steel cases or in leather cases, and with or without push button handle opener, as desired.

Ask for Steel Tape Book showing styles, sizes and prices.

Catalogue 18-D for general line of small tools.

The L. S. Starrett Co.

Athol, Mass.

NEW YORK CHICAGO LONDON

The Winning of a Medal

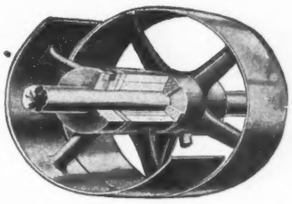
stamps a machine or mechanical device with the approval of the best judges—puts a label on it, so to speak. We're proud to say

Arguto Oilless Bearings

won the gold medal at Jamestown in 1907, and we have every reason to believe will win out at the next exposition—but the fact that loose pulleys fitted with these bearings have run continuously

2504 Days

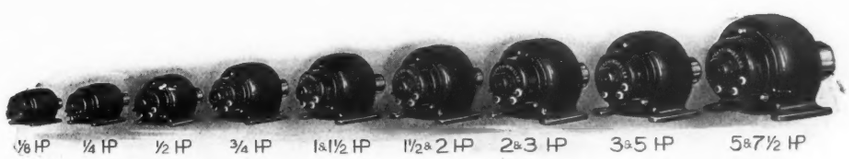
without oiling or attention, puts a label of efficiency on Arguto we would not trade for any number of awards.



Loose Pulley Equipment.
(PATENTED)

ARGUTO OILLESS BEARING COMPANY
WAYNE JUNCTION, PHILADELPHIA, PA.

Motor-Drive Specialists since 1888



Bulletin 98R describes this motor in detail.

Behind the Crocker-Wheeler Form L motor is the experience of a company that has specialized in motor-drive for machine tools since 1888.

We are able to solve motor-drive problems that seem insoluble.

CROCKER-WHEELER COMPANY

Manufacturers and Electrical Engineers

AMPERE, N. J.

BARR DRILLS

The output of your machines, their accuracy, convenience and general efficiency determine your profits.

If your business calls for the drilling of many holes, you will be interested in Barr Drills. Write for details.

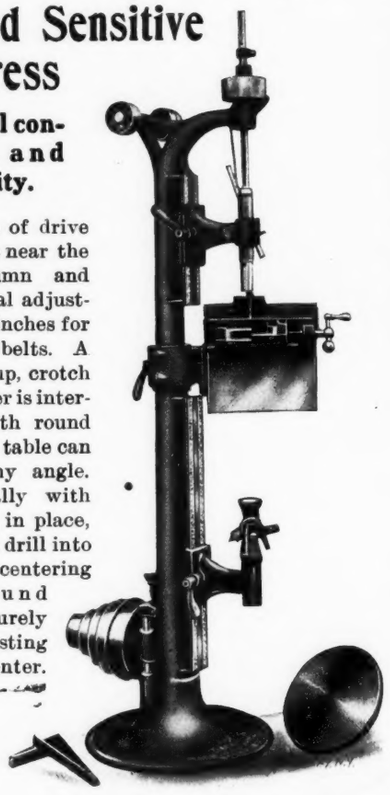
H. G. BARR, Worcester, Mass.

Improved Sensitive Drill Press

of unusual convenience and adaptability.

The new form of drive places the cone near the base of column and allows a vertical adjustment of three inches for tightening the belts. A combination cup, crotch and point center is interchangeable with round table. Square table can be set at any angle. Tilted vertically with centering vise in place, it converts the drill into a practical centering machine — round stock held securely in vise and resting in the cup center.

Ask for circular with full description.



Rockford Machine and Shuttle Co.
ROCKFORD, ILL., U. S. A.

NOTICE

Data Sheets now $2.50 for complete set will be

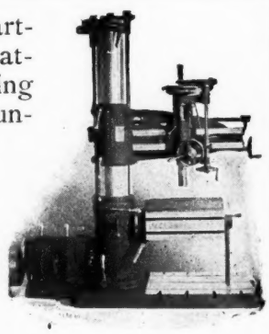
$4.00

after August 1, 1909.

See announcement on pages 133 and 134.

MACHINERY
49-55 Lafayette St., New York City

IF your drilling department is not giving satisfaction, consult a drilling specialist. We come under that heading and will be delighted to give you a description of a certain Radial Drill that is veritably a coining machine.

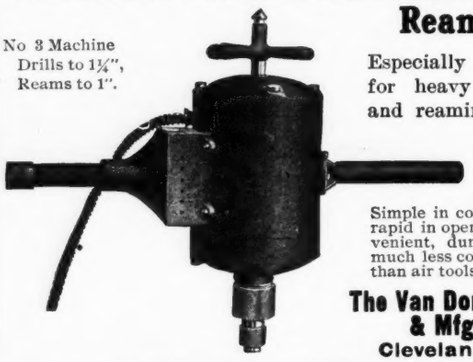


ARE YOU FROM MISSOURI?

THE MUELLER MACHINE TOOL CO., - Cincinnati, Ohio

Van Dorn Portable Electric Drills and Reamers

No 3 Machine Drills to 1¼", Reams to 1".



Especially designed for heavy drilling and reaming.

Ask for particulars.

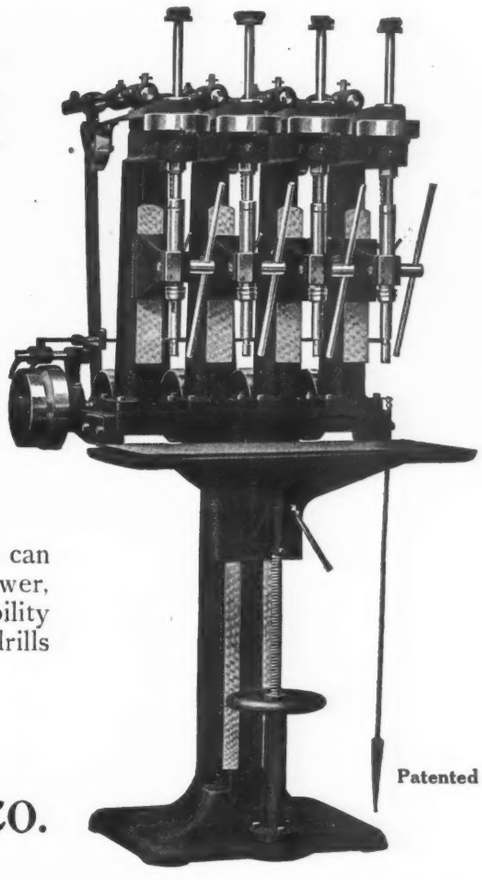
Simple in construction, rapid in operation, convenient, durable and much less costly to run than air tools.

The Van Dorn Electric & Mfg. Co.
Cleveland, Ohio

NEW YORK OFFICE: 126 Liberty Street.

200 TO 400 PER CENT. IS A BIG ADVANTAGE

The fact that the number of BALL BEARING DRILLING MACHINES sold in 1909 has already exceeded the sales for the entire year of 1908, would indicate a very general awakening to the merits of these superior machines.



Patented

200 to 400 per cent. more holes in a given time than can be produced with any other drill press, economy in power, convenient operation and almost phenomenal durability are a few reasons why they are replacing so many drills of other makes.

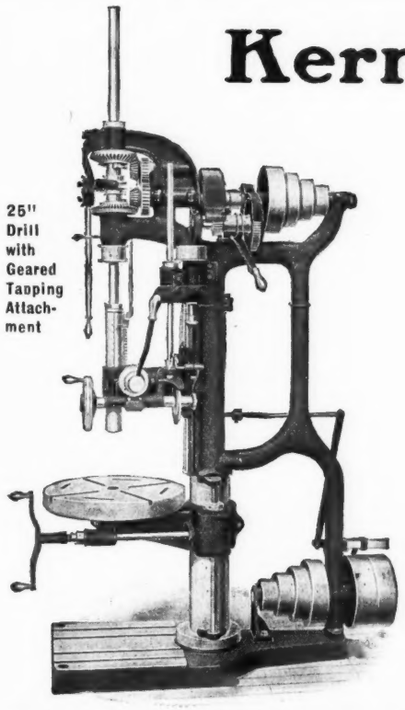
Catalogue for further reasons.

THE HENRY & WRIGHT MFG. CO.

HARTFORD, CONN., U. S. A.

Kern Upright Drills

The most thoroughly modern drills on the market.

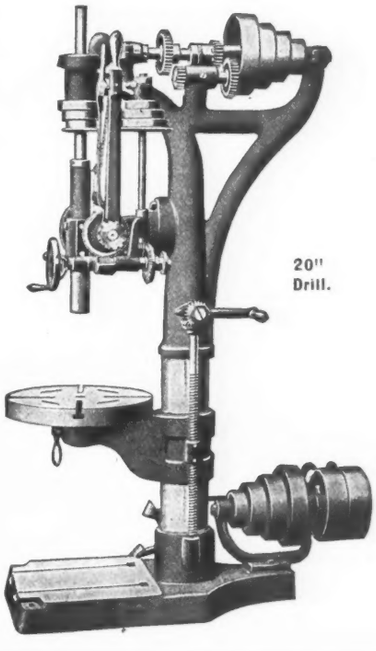


25" Drill with Geared Tapping Attachment

Combine simplicity and ease of operation with strength and rigidity for the heaviest work.

Sizes from 15" to 42" inclusive.

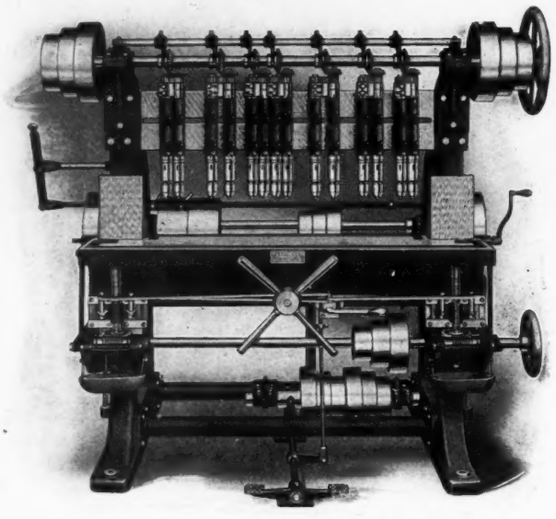
"The Drills That Make Good."



20" Drill.

THE KERN MACHINE TOOL CO., Cincinnati, O.

AGENTS:—Vandyck-Churchill Co., New York and Philadelphia. Chandler & Farquhar Co., Boston. C. H. Wood Co., Syracuse. Aumen Machinery and Supply Co., Baltimore. The E. L. Essley Machinery Co., Chicago. Fairbanks Co., New Orleans. Crane Co., Birmingham. Henshaw-Bulkley & Co., San Francisco. Hendrie & Bolthoff Mfg. & Supply Co., Denver. Williams & Wilson, Montreal, Canada. A. R. Williams Machinery Co., Toronto, Canada. Alfred Herbert, Ltd., Coventry and Paris. De Fries & Co., Dusseldorf and Milan. G. Koeppen & Co., Moscow. J. Lambercier & Co., Geneva. Nienstaedt & Co., Copenhagen. Henri Nyssens, Antwerp. Van Rietschoten & Houwens, Rotterdam. New York Export & Import Co., Japan, China and the Far East.



Multiple Spindle Iron Drilling Machine

A rapid working, labor-saving machine that will simultaneously drill 14 half-inch holes in steel to a depth of 7 inches. All spindle heads adjustable to drill at any point lengthwise of the rail in a straight line. Simple, convenient and adapted for metal drilling of all kinds. We manufacture this style of machine in various sizes with any number of spindles.

Write us for full description.

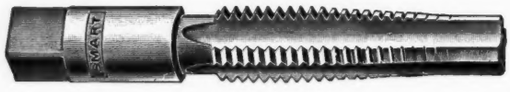
M. L. ANDREW & COMPANY
2850 Spring Grove Ave., Cincinnati, Ohio

SMART

TAPS AND DIES ARE BOUND TO KNOW YOU SOMETIME—ALTHOUGH YOU MAY NOW SWEAR BY SOME OTHER MAKE.

CATALOG?

A. J. SMART MFG. CO., Greenfield, Mass.



Years of experience have taught us how to make taps and dies well.

WE ALWAYS MAKE

BAY STATE

JUST AS WELL AS WE KNOW HOW.

The superior temper, correct lead and uniform pitch of our screw cutting tools are all the result of trying hard to produce a better article each time.

Taps and dies to A. L. A. M. Standards and a full line of Screw Cutting Tools in stock.

Write for the Tap book.

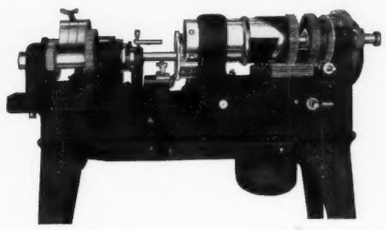
Bay State Tap & Die Company
Mansfield, Mass., U. S. A.

Stewart Gas Blast Furnaces For Heating High Speed Steel

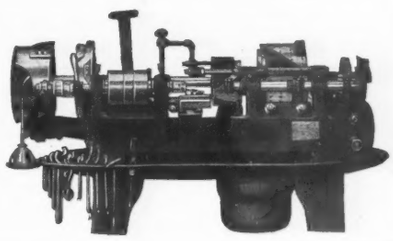
Have reduced to the minimum the difficulties that heretofore surrounded this class of work. There is an absolute control of temperature, no danger of scale, the flame is non-oxidizing and the whole process simple, economical and sure.

Ask for our Catalogue.

Chicago Flexible Shaft Company
149 LaSalle Ave., Chicago, Ill., U. S. A.

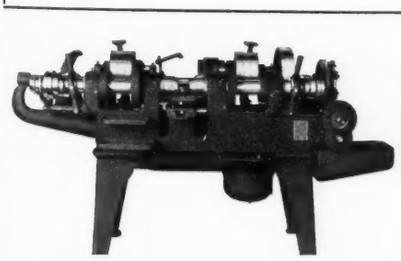


PERTINENT FACTS ANENT CLEVELAND AUTOMATICS



WE thought, perhaps, the readers of MACHINERY would be interested to know that the Cleveland Automatic Machine Company's American business at this time is about normal, which is a strong indication that business is improving all over the country. We are hiring men as fast as they come along and intend to add, at least, 150 skilled men to our force as rapidly as we can obtain them.

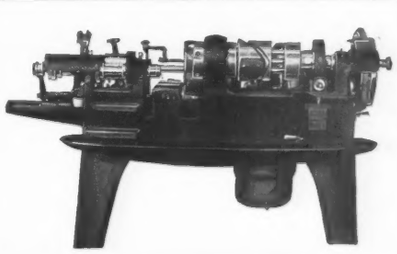
We also wish to mention that the Perry-Fay Mfg. Company, of Elyria, Ohio, in the last two weeks have placed with us an order for $25,000.00 worth of Automatics and, in the near future, when they can figure out what they require, they expect to place another order as large as the one mentioned above. The reason for this is, they are so extremely busy and are now adding another large addition to their factory. We believe they intend to double their capacity. In the last two years this Company has ordered from us 115 Automatics, in sizes from 3/8" to 6", and they are kind enough to inform us that these 115 machines have been running constantly since they were purchased and the repairs, in any form, on this lot of machines have not cost them $10.00. We think this speaks extremely well for the "Cleveland" and our reasons for advertising the matter is that the Perry-Fay Company voluntarily gave us this information. We might also say that this Company invite any one, who so desires, to visit their factory in Elyria to verify this statement. They are manufacturers of screws and parts of all descriptions made from the bar and, naturally, the Cleveland Automatic Machine Company are proud to be able to publicly state to prospective customers that their machines, when properly handled, give unparalleled satisfaction.



Cleveland Automatic Machine Company

Cleveland, O., U. S. A.

Eastern Representative—J. B. Anderson, 2450 No. 30th St., Philadelphia. Western Representative—H. E. Numa, 67 W. Washington St., Chicago. Foreign Representatives—Chas. Churchill & Co., London, Manchester, Birmingham, Newcastle-on-Tyne and Glasgow. Messrs. Schuchardt & Schutte, Vienna, Berlin, St. Petersburg, Stockholm, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milano and Bilbao.



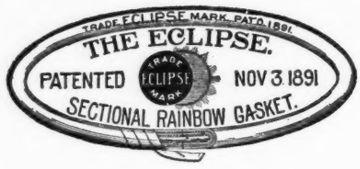
The Eclipse Sectional Rainbow Gasket

The Eclipse Sectional Rainbow Gasket is the only tubular Gasket in the world that will hold 3,000 pounds pressure and that will do the work. Why? Because it is the only Gasket that is made of the

Celebrated

Rainbow Packing Compound

⅜-inch, ½-inch, ⅝-inch
For Hand Holes
In Boxes 3 to 5 lbs.



¾-inch, ⅞-inch. 1-inch
For Extra Large Joints
In Boxes 4 to 6 lbs.

Fac-Simile of a 6-inch Section of Eclipse Gasket Showing Name and Trade-Mark Imbedded

We have the most modern and extensive Rubber Factory in the world and manufacture the highest grade of all kinds of mechanical rubber goods, including

Pump Valves	Rubber Gas Bags	Faucet Balls
Gauge Glass Rings	Rubber Hat Bags	Garden Hose
Gaskets and Rings	Fire Hose	Tubing
Rubber Buckets and Pails	Landing Pads	Diaphragms
Discs	Hose Nipple Caps	Air Brake Hose
Rubber Belting	Mats, Matting	Steam Hose
Packings	Rubber Mallets	Suction Hose
Rubber Springs	Tiling	Pneumatic Tool Hose

SOLE MANUFACTURERS OF THE CELEBRATED RAINBOW PACKING

MANUFACTURED EXCLUSIVELY BY

The Peerless Rubber Manufacturing Company

16 Warren Street and 88 Chambers Street, New York

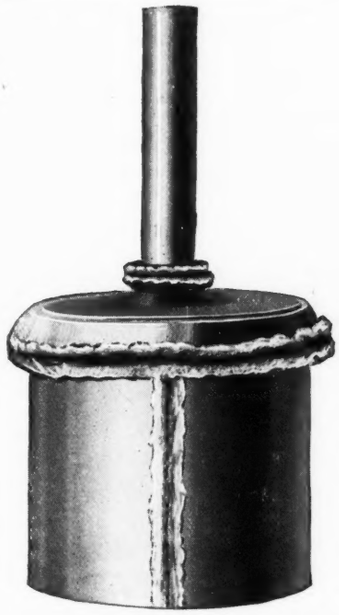
Detroit, Mich., 24 Woodward Ave.
Chicago, Ill., 202-210 South Water St.
Indianapolis, Ind., 18 S. Capitol Ave.
Louisville, Ky., N. E. Cor. Second and Washington Sts.
New Orleans, La., Cor. Common and Tchoupitoulas Sts.
San Francisco, Cal., 416-422 Mission St.
Seattle, Wash., 212-216 Jackson St.
Omaha, Neb., 1218 Farnam St.
Spokane, Wash., 1016-1018 Railroad Ave.

Richmond, Va., 1323 E. Main St.
Philadelphia, Pa., 245-247 Master St.
Dallas, Texas, 177 Elm St.
Memphis, Tenn., 228 Front St.
St. Louis, Mo., 1213 Locust St.
Denver, Col., 1621-1639 Seventeenth St.
Kansas City, Mo., 1221-1223 Union Ave.
Waco, Texas, 709-711 Austin Ave.
Tacoma, Wash., 1316-1318 A St.

Pittsburg, Pa., 425-427 First Ave.
Atlanta, Ga., 7-9 S. Broad St.
Columbus, Ohio, Cor. Long and Third Sts.
Cleveland, Ohio, 61 Franfort St.
Buffalo, N. Y., 379-383 Washington St.
Boston, Mass., 110 Federal St.
Syracuse, N. Y., 212-214 S. Clinton St.
Rochester, N. Y., 55 E. Main St.
Portland, Ore., 27-29 N. Front St.

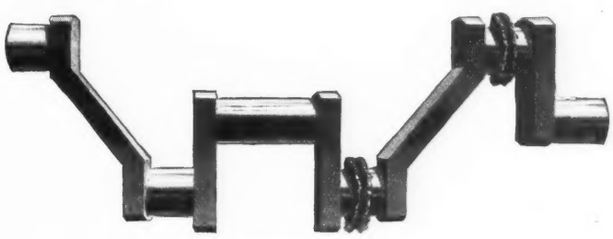
The articles illustrated were all

WELDED
BY
ELECTRICITY



The cut to the left shows a **Cream Separator Bowl,** the bowl proper and forging are both made from **Open Hearth Steel,** to which we **electrically weld** a spindle of **High Carbon Steel.**

The cut to the right shows our method of manufacturing a **Shovel Tang** by **electrically welding** a piece of **Tapered Standard Seamless Steel Tube** to a **Drop Forging,** the most simple, most economical, most reliable method of manufacturing this and similar articles. There are new and improved features being brought out each year, many of which can be made possible and others greatly simplified only by the aid of **Electric Welding.**



This cut shows our method of producing a **special Multiple Throw Crank Shaft.** We are especially well equipped to weld single throw rough forgings to create multiples of any denomination. We have welded many thousand crank shafts in the last few years and have never received a single complaint. All welds are made in the wrist pins or bearings, with throws welded to degrees of angle only when forgings are especially prepared.

By our method you eliminate the producing of and maintaining expensive forging dies necessary when forged continuous, also overcome that buckle or warp that usually results from a continuous forging.

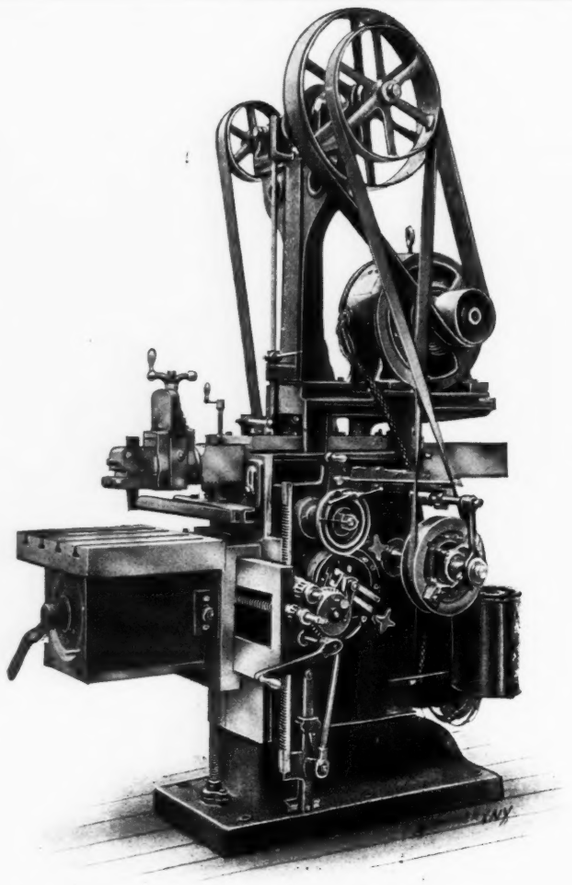
Send for illustrated booklet E.

THE STANDARD WELDING COMPANY

Western Representative, L. F. McCLERNAN
1064 Monadnock Block, CHICAGO

CLEVELAND

Eastern Representative, L. D. ROCKWELL
U. S. Express Bldg., NEW YORK



Morton's New Improved 26-inch Draw-Cut Shaper

Is equipped with Rotating Box Table, instantaneous change of feed, and power adjustment for the horizontal and vertical movements of the cross-rail.

No wrench is required to shorten or lengthen the stroke.

Its accuracy and cutting power are beyond the ability of high-speed steel.

The machine can be equipped with special attachments, designed for the completion, at one setting, of locomotive driving box brasses, whereby they are ready to press into the box direct from the machine; also special Rod Brass attachment designed for the machining of the brass complete for rod strap fits, at one setting.

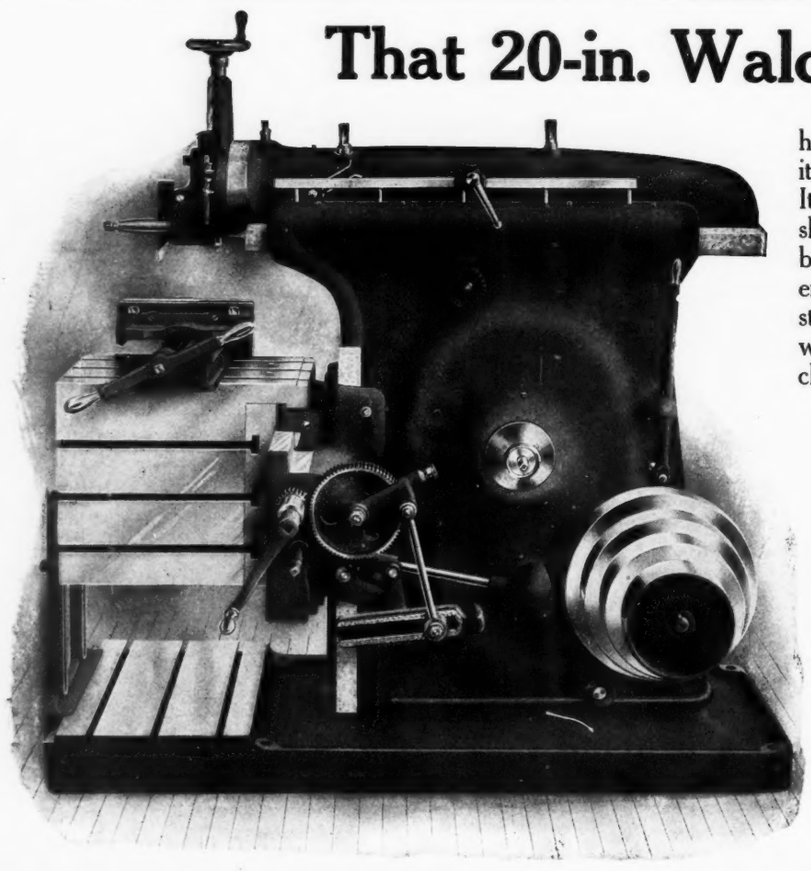
It can be furnished electrically driven or belt driven, as desired.

When you read this, just write for photographs and descriptive matter.

Morton Manufacturing Company

MUSKEGON HEIGHTS, MICH.

That 20-in. Walcott Shaper



has already made a name for itself among the manufacturers. It differs from the ordinary crank shaper in many essentials, has been designed with special reference to increased strength and stiffness, and to the correction of weak points common to this class of machine, and will handle a wide range of work efficiently and economically.

Ask for circular with full description.

Walcott & Wood Machine Tool Co.

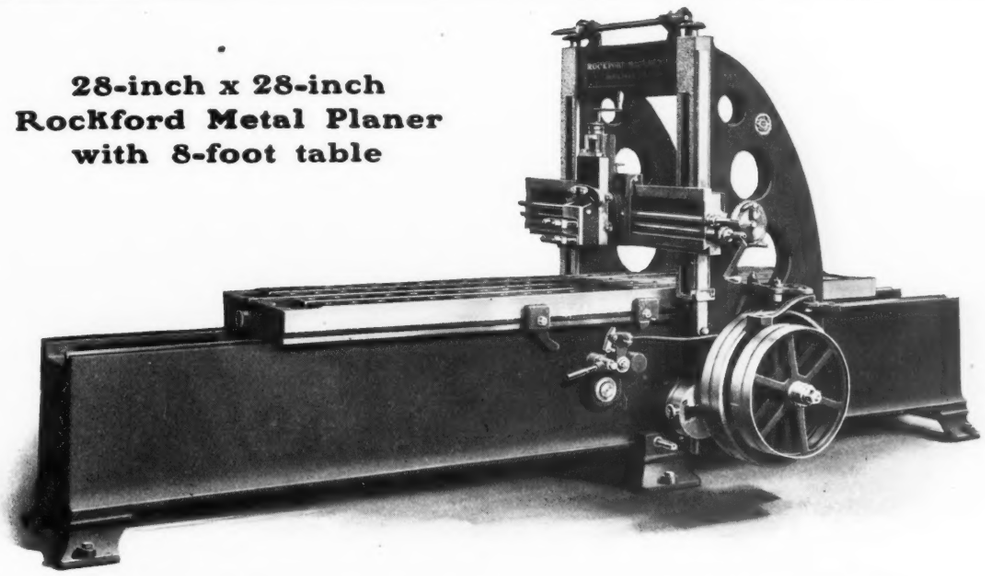
Succeeding
GEO. D. WALCOTT & SON

JACKSON, MICH.

AGENTS: Frevert Mchy. Co., New York. Chandler & Farquhar Co., Boston. Chas. G. Smith Co., Pittsburg. Strong, Carlisle & Hammond Co., Cleveland. H. A. Stocker Mchy. Co., Chicago.

FOREIGN AGENTS: Fenwick Freres & Co., Paris. Buck & Hickman, Ltd., London.

28-inch x 28-inch Rockford Metal Planer with 8-foot table



ROCKFORD PLANERS

Improved metal planing machines designed to handle a wide range of work efficiently and accurately. Construction is massive, proportions correct, all gears are located inside the bed between the bearings, giving great rigidity to the machine, insuring safety to the operator and protection of gears from falling chips or other injury. Furnished with one or two heads on the crossrail; any length of bed—even lengths. Four sizes, 24, 28, 32 and 36-inch.

Also builders of the Rockford Shapers—12, 16, 20 and 24-inch. Ask for circulars.

Rockford Machine Tool Company, Rockford, Ill., U. S. A.

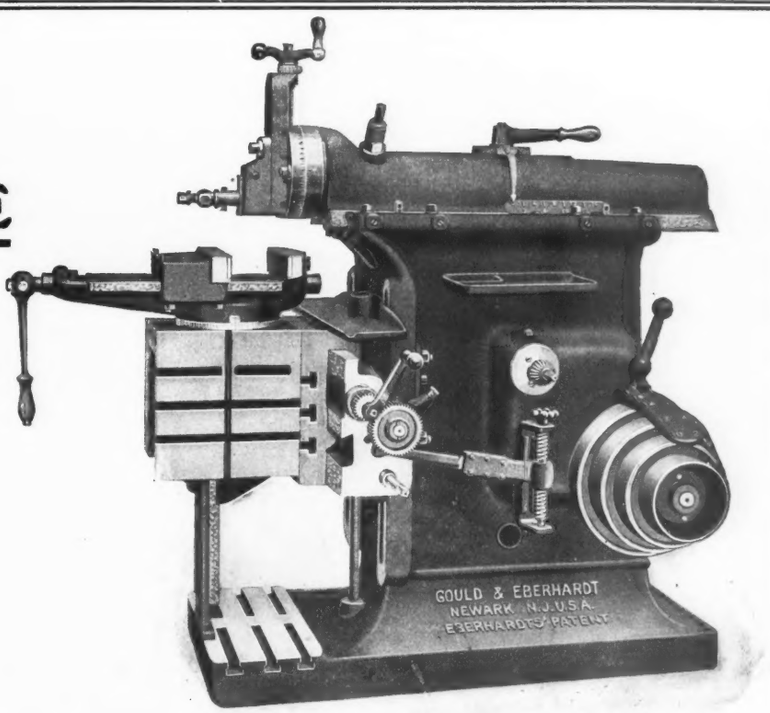
THE STANDARD EVERYWHERE

Eberhardts' Patent

"High-Duty" Shaper

The best shaper made. Everywhere in use, and everywhere recognized as THE STANDARD because the best, and the best because designed right and built right.

It will do more and better work, and last longer with a minimum of expense for repairs than any other shaper. Our new catalog tells about the "Double Train" Gear Drive and other profit-producing features.



GOULD & EBERHARDT

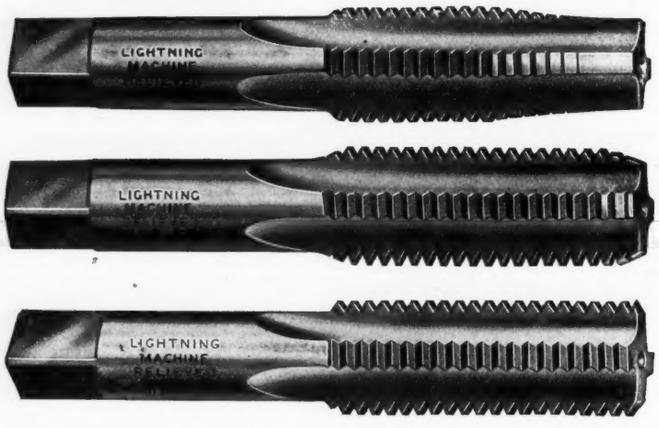
"HIGH DUTY" SHAPERS
AUTOMATIC GEAR AND RACK CUTTING MACHINERY

ESTABLISHED 1833 NEWARK, N.J. U.S.A.

LIGHTNING "Machine Relieved" TAPS

GUARANTEED { Accurate / Uniform / Durable

37 Years on the market



Every tooth relieved like a Milling Cutter

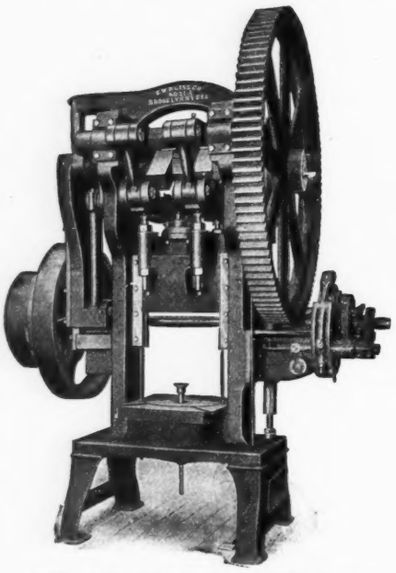
Used by Railroads and Largest Manufacturers all over the world.
Carried in stock by leading Hardware Jobbers and Dealers.

SEND FOR CATALOG 34-E.

WILEY & RUSSELL MFG. COMPANY
GREENFIELD, MASS., U. S. A.

British Agents—Selig, Sonnenthal & Co., 85 Queen Victoria Street, London, E. C.

FOR DRAWING AND FORMING SHEET METAL



"Bliss" Patented Toggle Drawing Press

in the manufacture of shells, lamp founts, seamless cans, enamelled ironware, brass and copper goods of all kinds, the presses that give the **BEST RESULTS** are the

"BLISS"
TOGGLE DRAWING PRESSES
(PATENTED)

They are built in sizes to cover all classes of work. When equipped with the **"BLISS"** Automatic Friction Clutch they can be started or stopped at any point of the stroke. The patented Toggle Movement insures a more perfect dwell, greatly increases smoothness of action, and effects a saving in friction and power. As fast producers of high class work they are the leaders. Send samples for estimates, or write for pamphlet illustrating these machines.

"PRESSES FOR EVERY PURPOSE"

E. W. BLISS COMPANY
5 ADAMS STREET **BROOKLYN, N. Y., U. S. A.**

Representatives for Chicago and vicinity: Stiles-Morse Co., 67 West Washington St., Chicago, Ill.

European Office: 100 Boulevard Victor-Hugo, St. Ouen (Paris), France. London Office: 114 Queen Victoria St., London, E. C., England.

"MORSE" DRILLS

A Drill that has always made its way where quality and efficiency have been the points considered.

45 Years

of Experience in Drill Making Enables us to make the Most Serviceable Drills.

Sizes from 1-16" to 6"

Variety of Styles

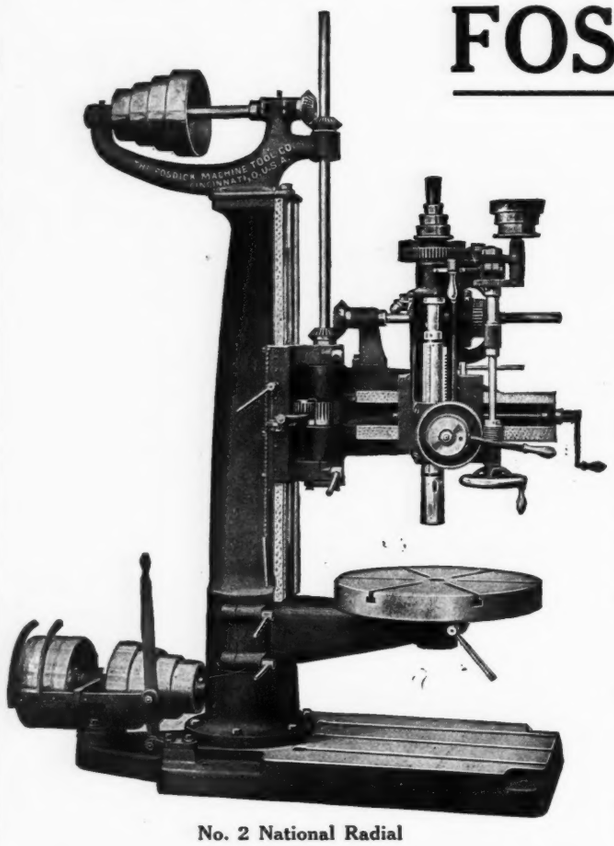
CARBON OR HIGH SPEED STEEL

Send for our Catalog—Free

Morse Twist Drill & Machine Co.

New Bedford, Mass., U. S. A.

FOSDICK RADIAL DRILLS



No. 2 National Radial

There's a comfortable assurance of the maximum production from every machine and a guarantee of accurate work if you are equipped with Fosdick Radials. These machines are of improved design, strong and stiff in construction, have back gears and tapping attachment, wide range of feeds and speeds and will outwork and outwear any tools of their class.

Ask us for particulars.

The Fosdick Machine Tool Co.
CINCINNATI, O., U. S. A.

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, E. C. R. S. Stokvis & Zonen, Rotterdam, Holland. Fenwick Freres & Co., Paris, France. Ludw. Loewe & Co., Berlin, Germany. Adolfo B. Horn, Havana, Cuba. Bevan & Edwards, Propty. Ltd., Melbourne, Australia.

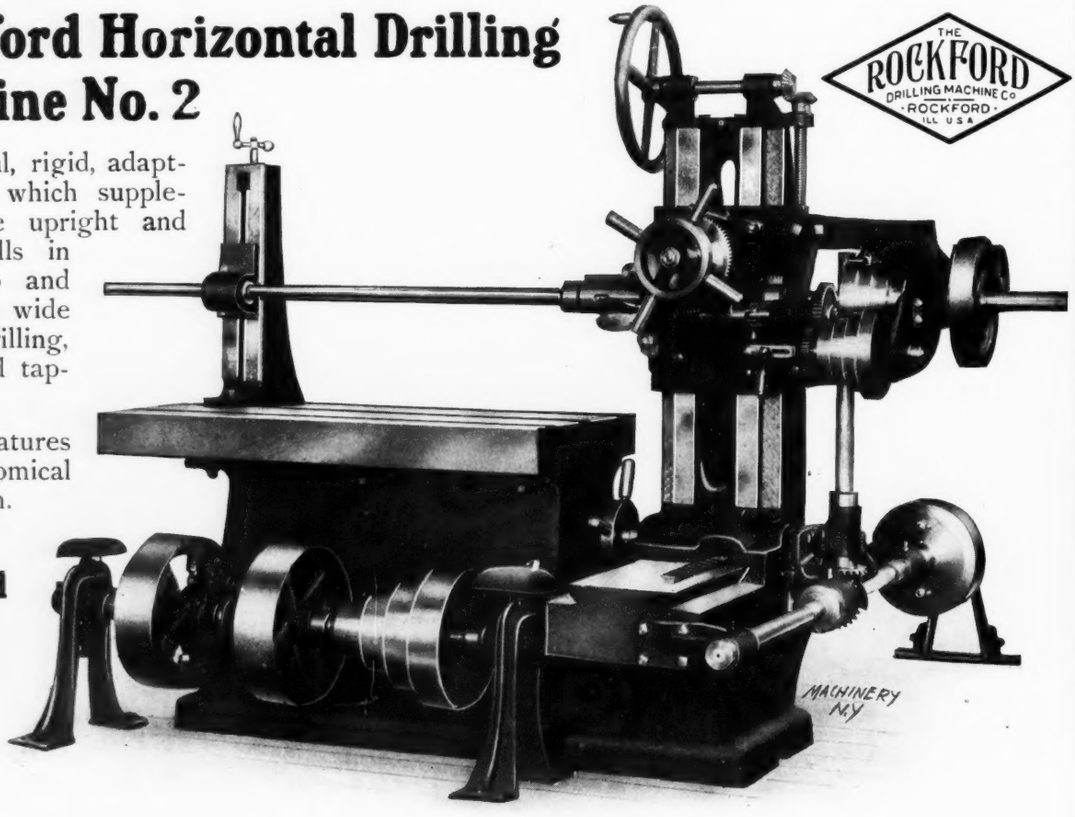
Rockford Horizontal Drilling Machine No. 2

A powerful, rigid, adaptable tool which supplements the upright and radial drills in the shop and handles a wide range of drilling, boring and tapping.

Special features for economical production. Write

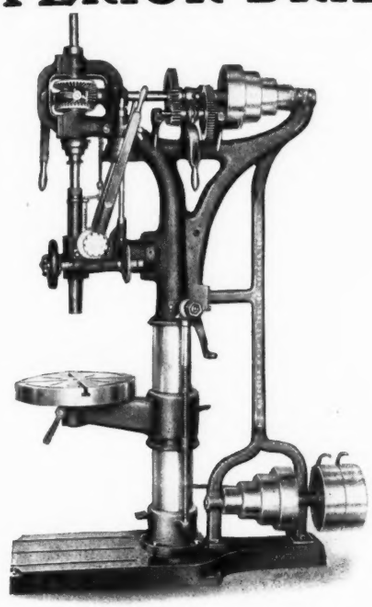
Rockford Drilling Machine Co.

Rockford, Illinois, U. S. A.



Henri Benedictus, Agent for Belgium; Edgar Bloxam, Agent for France and Italy; Thomas McPherson & Son, Melbourne; New York Export & Import Co., Agents for India, Japan, China and the Phillippine Islands; Alfred H. Schutte, Agent for Western Germany, Switzerland, Spain and Portugal; Theodore Butler, 149 Queen Victoria St., London, E. C.

SUPERIOR DRILLS



23-inch Superior Drill

With Back Gears, Power Feed and Tapping Attachment. A *superior* tool in every respect, strong, rapid and efficient.

We make a full line of Upright Drills.
Send us your inquiries.

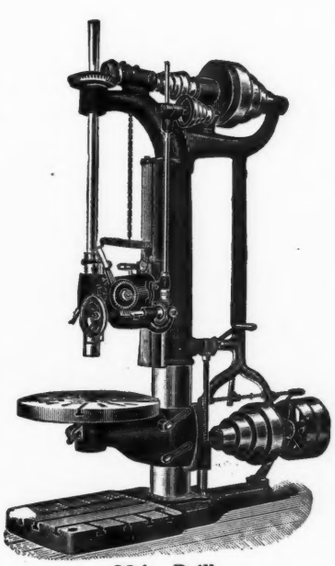
The Superior Machine Tool Co.
KOKOMO, IND.

OUR LINE

BELT FEED
OR
"POSITIVE FEED"

32-in.
26-in.
24-in.
20-in.
14-in.
14-in. B
13-in. B
Standard Drills

No. 1
No. 2
Friction Drills

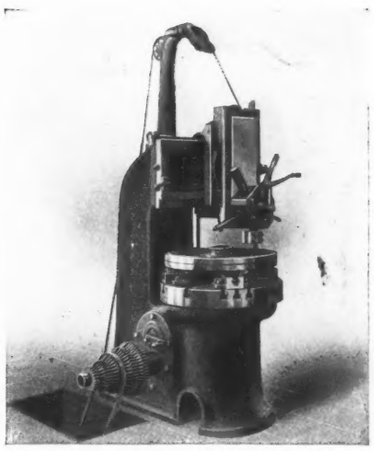


32-in. Drill

MECHANICS MACHINE CO.

19th Avenue, Rockford, Ill., U. S. A.

AGENTS: Garvin Machine Co., New York. C. W. Burton, Griffiths & Co., London. Ateliers Demoor, Brussels. R. S. Stokvis & Zonen, Rotterdam.



Cone-sprocket drive with Morse Chain to Bullard Boring Mill (S. O. 11601).

The Morse Silent-Running Rocker-Joint Chain

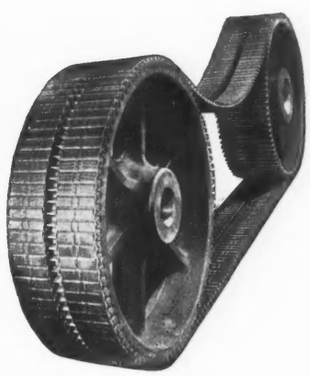
is in constant use at speeds up to 2000 feet per minute, running efficiently, quietly and smoothly.

It can be used where belt drives would be impossible on account of short centers, heat, dampness and other unfavorable conditions.

For many purposes it is cheaper than belting, occupies less space, is noiseless, and at all times provides a positive speed ratio.

Under equal conditions it will transmit, without joint wear, more power per inch of width than any other chain made.

See Catalogue No. 7.



Morse Chain Co.

ITHACA, NEW YORK

Licensees for Great Britain and Europe: The Westinghouse Brake Co., Ltd., York Road, Kings Cross, London, N.

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

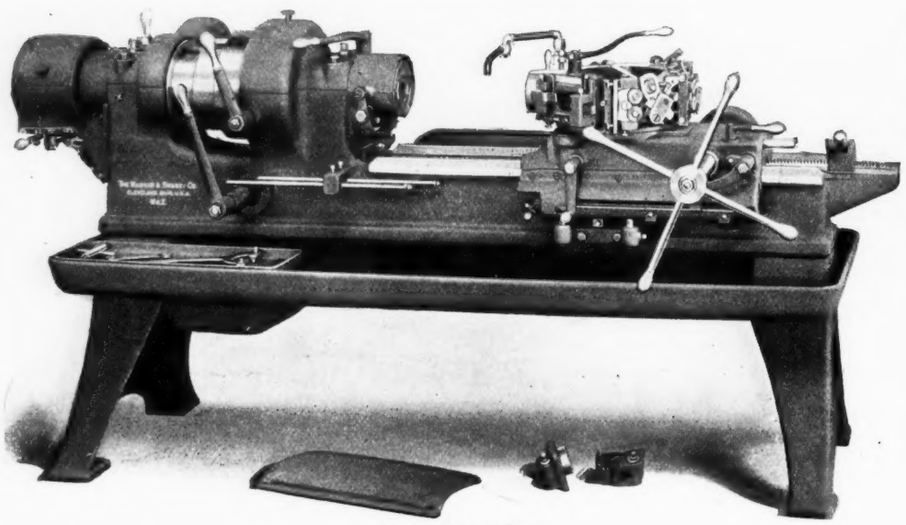
New York Office: Singer Bldg. *Detroit Office:* 100 Melbourne Ave. *Chicago Office:* Commercial National Bank Bldg.

Foreign Agents: Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Paris, Brussels, Liege, Milan, Madrid, Bilbao and Barcelona. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal.

Hollow Hexagon Turret Lathes

Made in four sizes

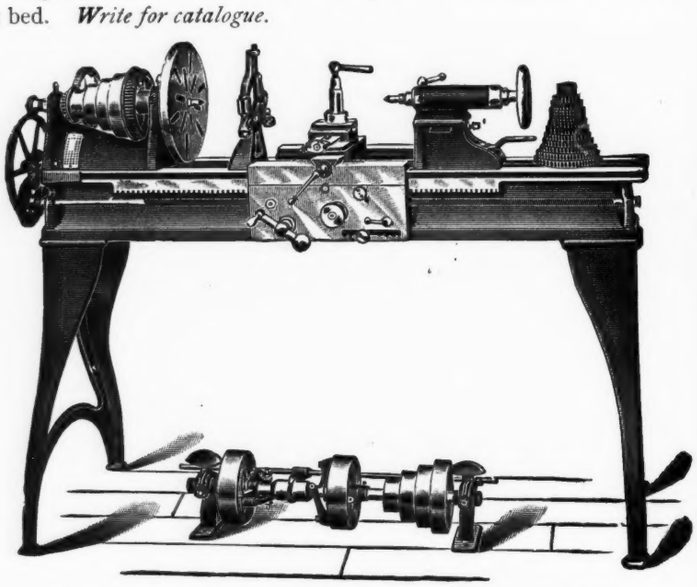
For a specified requirement there is a machine particularly adapted. They are rapid producers of duplicate parts from bar stock or forgings and similar work. Complete catalogue sent on request.



No. 2—2¼ x 24 Inch

These two tools make a pretty good start for a small machine shop. The drill is our No. 7—15-inch Swing Drill, a stiff tool for its size and well adapted for light medium work; just note the combined lever and wheel feed! The lathe is our No. 13 Lathe, swinging 13 inches over the face plate, and made in beds of 5 to 10 feet long; has automatic cross-feed and compound rest; very stiff tool carriage and eight changes of feed without removing a gear. We can furnish Lathe with foot power if wanted.

A good deal less than $200 will buy this Drill and the Lathe with 5-foot bed. *Write for catalogue.*

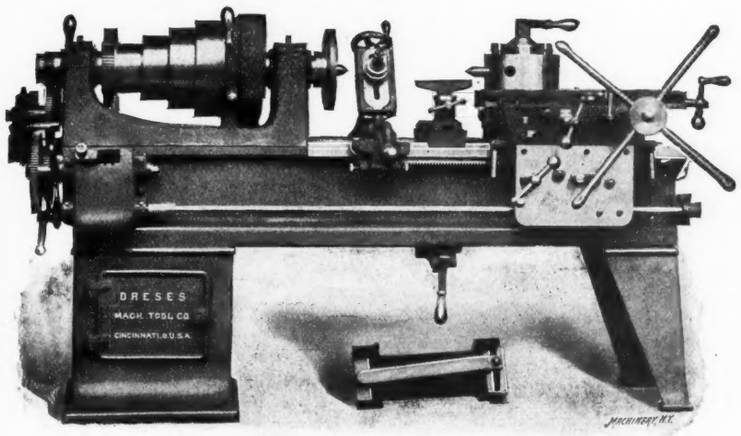


W. F. and JOHN BARNES CO.

231 RUBY STREET ESTABLISHED 1872 ROCKFORD, ILL.

TURRET AND BRASS LATHES

In this line we call special attention to our new **20" Full Universal Monitor Lathe** of which notice the following features:



20-inch Full Universal Monitor Lathe

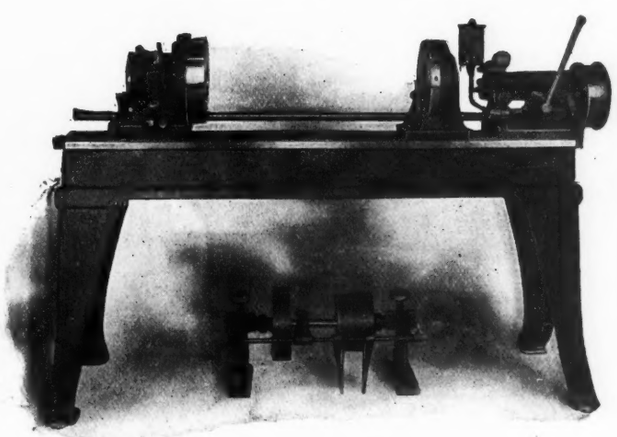
- Specially adapted for *general* brass and similar work.
- Geared feed so proportioned to cut 8, 11½, 14 and 18 (pipe) threads and others without change.
- Friction back geared head of the most approved and simple design.
- Eight changes of geared feed obtained instantly.
- Detachable pilot wheel to turret slides.
- Screw feed to turret slide for fine adjustment.
- Removable taper attachment.
- Straight and taper in and outside turning and screw cutting by means of turret and power feed.
- Semi-automatic turret.
- Chasing bar cuts right and left hand threads without changing.
- Three point principle support of bed to assure alignment.

DRESES MACHINE TOOL COMPANY, CINCINNATI, OHIO, U. S. A.

REPRESENTATIVES: The Fairbanks Co., New York, Philadelphia and Montreal. Carey Mchy. and Supply Co., Baltimore. O. L. Packard Mchy. Co., Chicago and Milwaukee. Wm. C. Johnson & Sons Mchy. Co., St. Louis. The Strong, Carlisle & Hammond Co., Detroit. Vandyck Churchill Co., Pittsburg. Pacific Tool & Supply Co., San Francisco. Selig, Sonnenthal & Co., London. E. Sonnenthal, Jr., Berlin and Köln. Wilh. Sonesson & Co., Malmo, Sweden. Stussi & Zweifel, Milan, Italy. Alfred Herbert, Ltd., Paris, France. White, Child & Beney, Vienna, Austria.

THE WHITON
Revolving Centering Machine

For Accurately Centering Finished Shafts



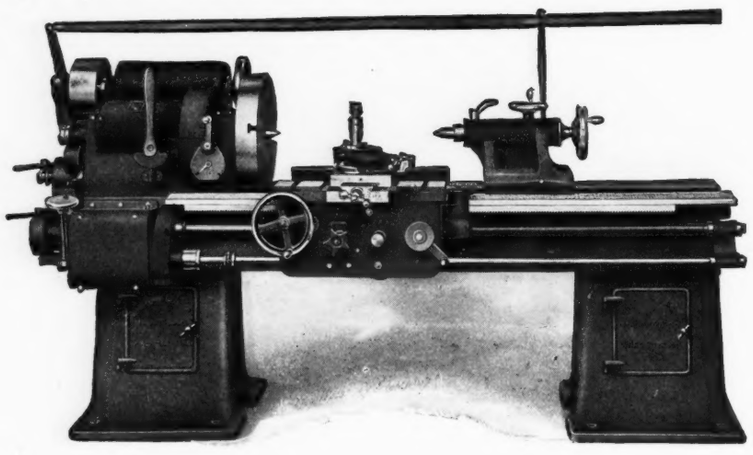
The cut shows new REVOLVING CENTERING MACHINE—a large size of the well known machine of this type. It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

Constructed same as the smaller machine and embodies all the special features.

Circulars and prices sent upon application.

The D. E. Whiton Machine Company
New London, Connecticut

WHITCOMB



The Unique Clutch for Feed Changes

which distinguishes the new Whitcomb-Blaisdell Lathe, combines the good points of both the positive and friction types and eliminates the faults of both. The spindle is positively driven, no shock in engaging or disengaging, no danger of continued slipping, as slipping only tightens the clutch more firmly.

This 16-inch Lathe, of the single speed pulley, gear-driven type, is smooth running, efficient, easily handled, very durable and develops great power The improved feed box and new chasing dial are points of vantage. All gearing in the head runs in oil, requiring very little attention, and all feed and speed changes can be made while the machine is running, or under the heaviest cut.

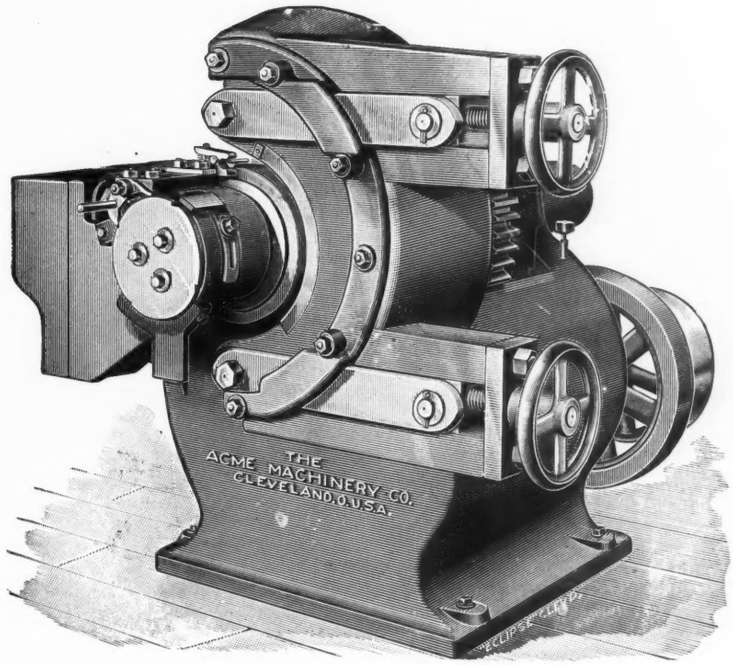
Ask for special bulletin and catalogue of our line of Second Belt Drive Planers.

Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass.

AGENTS: Hill, Clarke & Co., Boston, Chicago and Cleveland, O. Vandyck Churchill Co., New York and Philadelphia. Thomas & Lowe Machinery Co., Providence, R. I. C. H. Wood Co., Syracuse, N. Y. McDowell, Stocker & Co., Chicago, Ill. Marshall & Huschart Machinery Co., St. Louis, Mo. and Indianapolis, Ind. J. L. Osgood, Buffalo, N. Y. Perine Machinery Co., Seattle, Wash. Pacific Tool and Supply Co., San Francisco, Cal. Somers, Fitler & Todd Co., Pittsburg, Pa. Chas. A. Strelinger Co., Detroit, Mich. Zimmerman-Wells-Brown Co., Portland, Ore. Smith-Booth-Usher Co., Los Angeles, Cal. C. W. Burton, Griffiths & Co., London, England. Fenwick Freres & Co., Paris, France. Ludw. Loewe & Co., Berlin, Germany. De Fries & Co., Dusseldorf, Germany. Wilh. Sonesson & Co., Malmo, Sweden. Van Rietschoten & Houwens, Rotterdam, Holland. Williams & Wilson, Montreal, Canada. A. R. Williams Machinery Co., Toronto, Canada.

BLAISDELL

AN UNQUALIFIED SUCCESS



The "Acme" Rotary Thread Rolling Machine

is one of the recent additions to our line, and was not put on the market until we were satisfied that it possessed all the qualities that distinguish "Acme" machines in general. It has been "tried out" under the most severe conditions and proved an unqualified success. It is compact and convenient in design and operation, embodies a number of advantages over similar machines and is made in the following sizes:— ¼" to ½", ½" to 1", and 1" to 2". Ask for special bulletin.

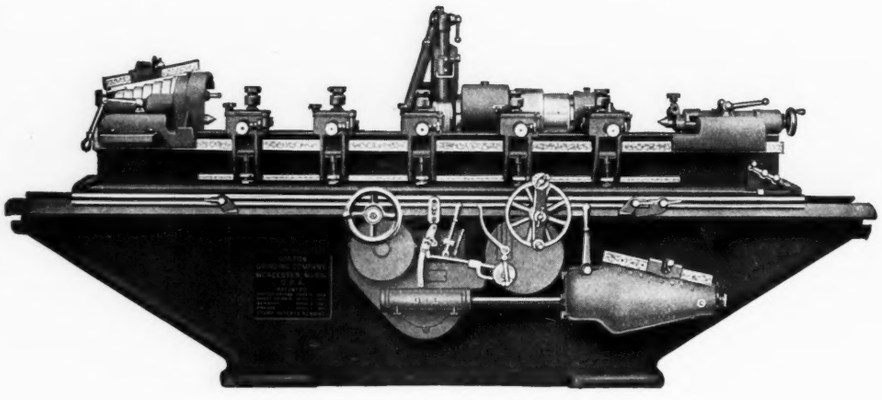
We also build the "Acme" Upsetting and Forging Machines, Bolt and Rivet Headers, Nut Tappers, Bolt Pointers, Bolt Cutters, etc. Catalogue on request.

The Acme Machinery Company

Cleveland, Ohio, U. S. A.

FOREIGN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg Alfred H Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. C. W. Burton, Griffiths & Co., London, England.

ANYBODY CAN GUARANTEE
A Large Production of Ground Work



What you need to know is, what is the quality of the work, and the quality of the machine with which the work is done. Demonstration in your works

WOULD SETTLE IT.

Norton Grinding Machines
and
Norton Demonstrators

are at your disposal

AGENTS—

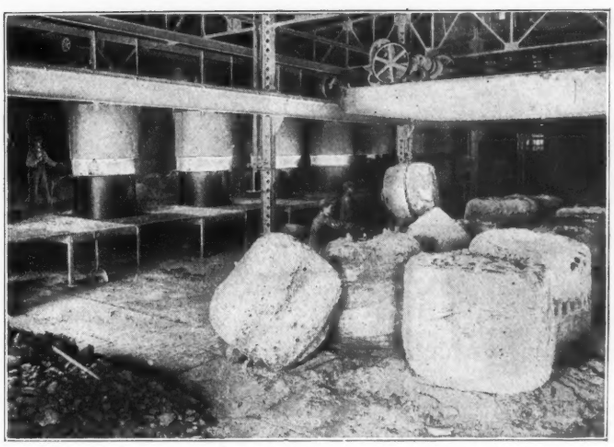
Vonnegut Hardware Co., Indianapolis.
Robinson, Cary & Sands Co., St. Paul and Duluth.
Manning, Maxwell & Moore, Pittsburg, St. Louis, Philadelphia, Atlanta.
Prentiss Tool & Supply Co., New York, Boston, Buffalo, Syracuse.
Motch & Merryweather Mchy. Co., Cleveland, Detroit and Cincinnati.
The Canadian Fairbanks Co., Montreal, Toronto, Vancouver.
Ludw. Loewe & Co., Ltd., London, Berlin, European Agents.
F. W. Horne, Yokohama, Japan.

Norton Grinding Company
Worcester, Mass.

Chicago Store: 48 South Canal Street

92-N

NORTON ALUNDUM



Making Alundum in Electric Furnaces

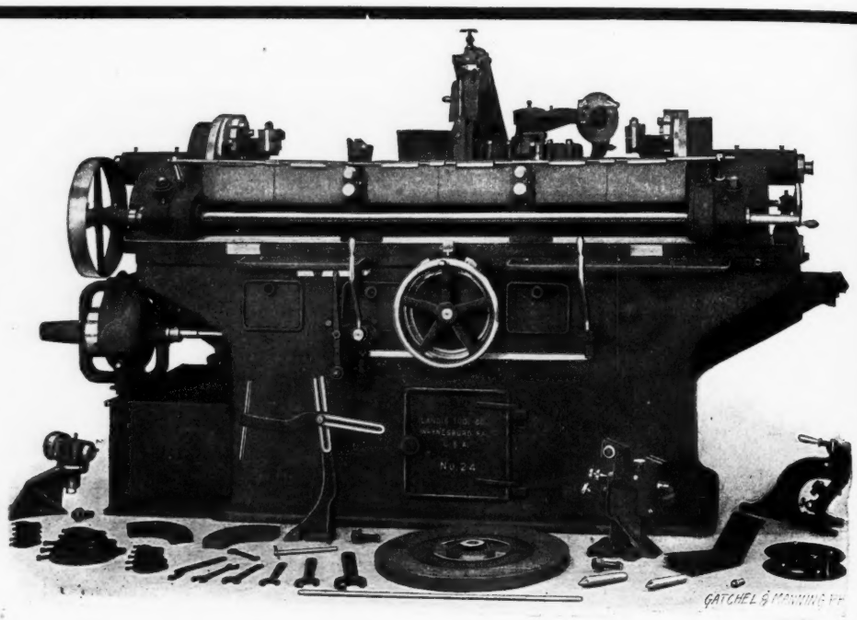
GRINDING WHEELS made of Alundum have many advantages due to the superior abrasive material produced in the electric furnace. Norton wheels have still further advantages due to manufacturing experience and scientific research. Alundum is sharp and is produced in the proper temper for grinding wheel manufacture. Hence Norton wheels are fast-cutting, and maximum production results from their use.

NORTON COMPANY
Worcester, Mass.

New York, 50 Church Street.
Chicago, 48 So. Canal Street.
Alundum Plant, Niagara Falls.

F-87

The Landis Grinder For Crank Shaft Work

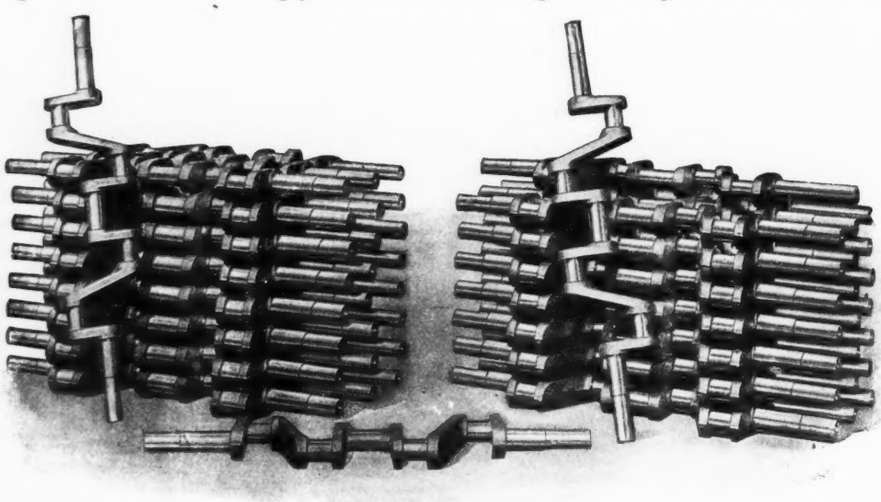


This machine is especially designed for the fast, accurate grinding of single and multiple crank shafts for gas, petrol and small steam engines.

It turns out perfect work of absolute uniformity and makes a saving of 30% to 40% in operating expenses over other methods.

This machine, like all other Landis Grinders, is a sure expense-reducer and profit-builder.

You ought to have a copy of our catalog. May we send it?



EXAMPLE OF WORK—Automobile Gas Engine Crank Shafts

Steel Forgings—case hardened. Parts ground—four wrists, each 1¾ inches diameter by 3½ inches long; three journals, each 1⅞ inches diameter, 3½, 4½ and 5½ inches long, respectively; two gear portions on end of shafts, each 1⅝ inches diameter by 3 inches long. A total of nine bearings all having been ground to size within .0005 inch variation limit. .025 inches diameter removed—average time taken, **80 minutes.** This includes the grinding and accurately forming of twelve ⅛-inch radius fillets at ends of the bearings.

Landis Tool Company, Waynesboro, Pa., U. S. A.

AGENTS—W. E. Flanders, 309 Schofield Building, Cleveland, Ohio, and 933 Monadnock Blk., Chicago, Ill. Walter H. Foster Co., 114 Liberty St., New York. C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Canada.

BESLY GRINDERS

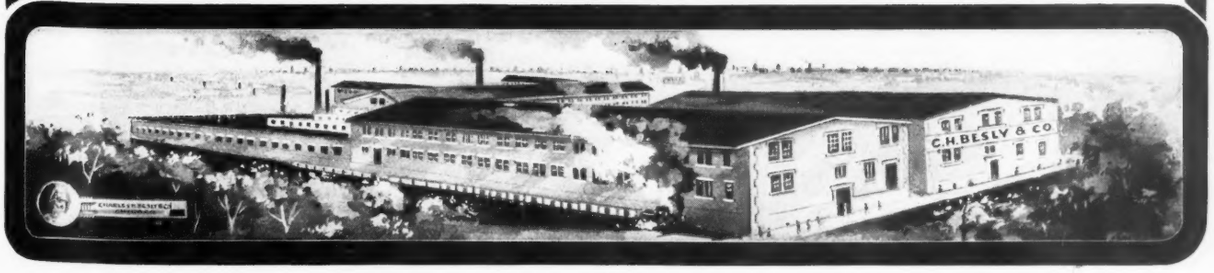
LET US SHOW YOU WHAT WE CAN DO FOR YOU

Illustration shows grinding of "U" Shaped Magnets, made from 3-8" x 3-4" Special Magnet Steel.
Material - Special Magnet Steel.
Ground on 1905 Model No. 6 Besly Spiral Disc Grinder.
Magnets are 5" from center of "U" to bottom of leg.
Used No. 5360, grain No. 16 Helmet Spiral Circle.
Stock removed:—just enough to clean up—from 1-32" to 3-32".
Time: 375 pieces per hour.
One pair of circles would last five hours.
The PATENTED FEATURES of No. 6 Besly Spiral Disc Grinder, illustrated above, are the
Spiral Grooved Steel Discs,
Helmet Spiral Circles,
Geared Lever Feed Mechanism, and
Sliding motion of Spindle.
Furthermore, with this machine, if desired, we are prepared to furnish our patented Hinged Nut Grinding Fixture, or our Patented Open Top Nut Holder.
The EXCLUSIVE FEATURES of this Machine are the
Bed Construction—Heads are mounted on V's planed on bed castings;
Method of taking up end thrust of Spindle,
Bearing Construction, and
Micrometer Adjustment.
When so ordered, this machine is equipped with Automatically Telescoping Dust Hood.
End Play in Spindle Bearings is adjusted in such a way that machine can be run safely with practically all end play taken up, naturally grinding work to size within closer limits.
Among our 70 varieties of Besly Disc Grinders is one just suited for your work.
We would like to prove our claims on some of your samples. No charge for the demonstration.
Send us some samples and we'll grind them for you and report time and material used.

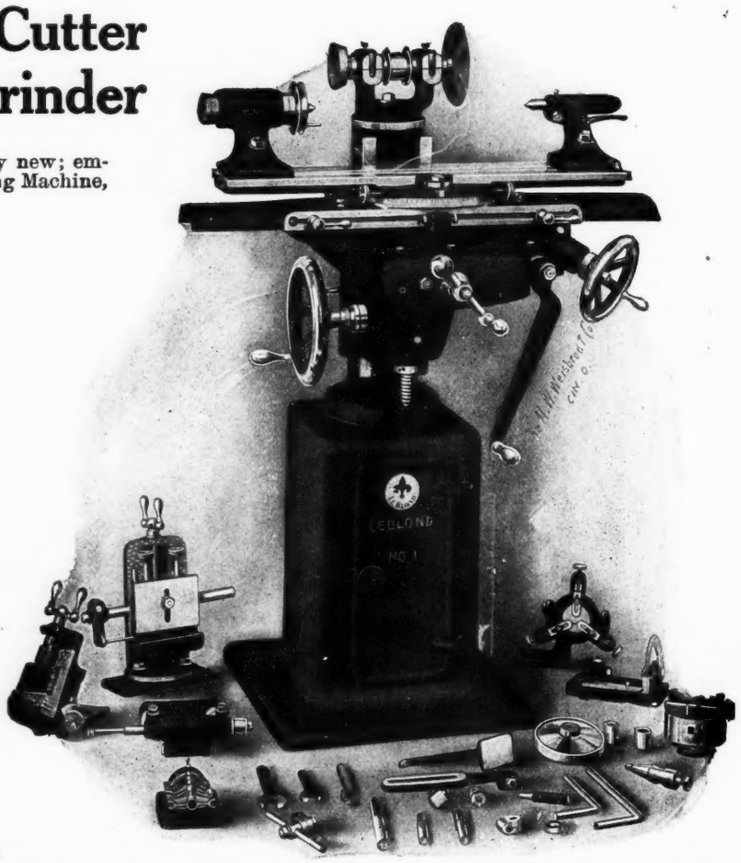
CHARLES H. BESLY & COMPANY

15-17-19-21 South Clinton St., (ORIGINATORS OF DISC GRINDERS) Chicago, Illinois, U. S. A.

Besly Works, Beloit, Wis., the home of the Besly Disc Grinders.



Universal Cutter and Tool Grinder



The Principle of the machine is entirely new; embodies the design of the Universal Milling Machine, consisting of a Knee, Saddle, Swivel, and Table. This gives rigidity that has heretofore been lacking in a Cutter Grinder, and adapts the machine to grind the large inserted-tooth mills of modern milling practice.

Capacity. It is absolutely universal; will grind any angle, taper or face. Grinds all kinds of cylindrical, internal faces and angular work; face and end mills, reamers, counterbores, circular saws, gear cutters, gauges, flat surfaces and other tool room work.

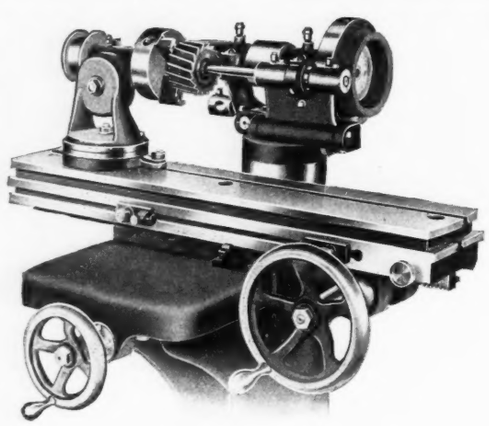
Attachments include a complete line. Universal Attachment, Circular Grinding Attachment, Internal Grinding Attachment, Gear-cutter Grinding Attachment, Surface-grinding Attachment, etc.

Catalogue giving full description of construction and use, will be mailed upon application.

The R. K. LeBlond Machine Tool Co.

4609 Eastern Ave., Cincinnati, O.

Internal Grinding



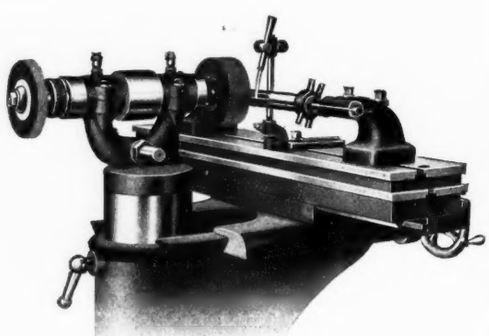
Internal Grinding on the Greenfield.

is quite within the scope of the **Greenfield Grinder.** The construction of the machine is such that the internal grinding attachment can be driven by a small friction wheel held against the periphery of the cup wheel holder by an adjusting screw. Special means are taken to insure the wheel holder running true. A light oil of some kind should be used on the spindle, and a coarse wheel has been found to give best results.

The means for holding the work in the 4″ chuck and holder is shown in the engraving.

Greenfield Grinders have a complete set of attachments for cylindrical and conical work, for grinding reamers, cutters, taps, dies, etc., and internal grinding.

Full details if you'll write us.



Grinding Clearance on a Reamer.

Greenfield Machine Co.

Greenfield, Mass.

THE EARNING POWER OF A GRINDING WHEEL

is what counts in the Economical Operation of your Grinding Department.

Carborundum Grinding Wheels

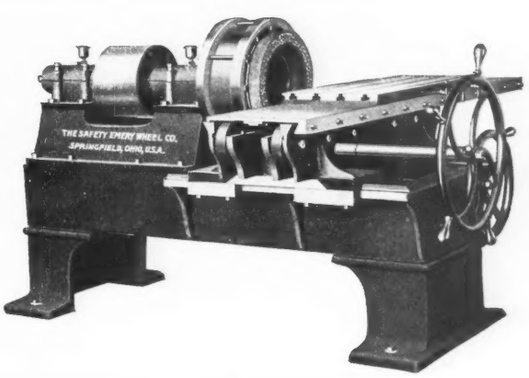
cut very fast and very clean—in many instances they *increase* the output of the grinding department 25 to 50 per cent—
And they not only do more work in a day but they last more days before wearing out.

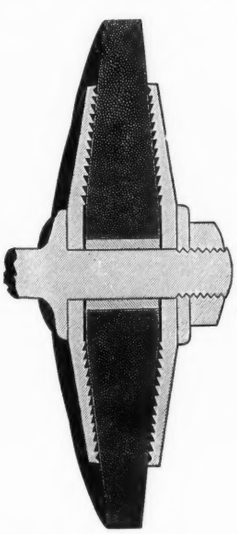
They are absolutely the most economical and satisfactory grinding wheels ever produced.

THE CARBORUNDUM COMPANY
NIAGARA FALLS, N. Y.

The Economy of High Speed Grinding

is not only in the time saved in the grinding operation but the wheel actually wears longer. The durability of a grinding wheel is in proportion to its speed. It is a well known fact that a wheel run at 4500 feet per minute will not wear half as long as a wheel run at 6000 feet per minute—





SAFETY EMERY WHEELS

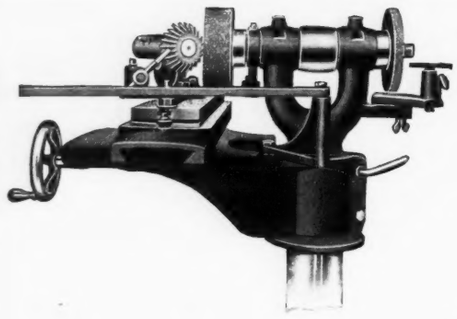
are high speed wheels. They are made for high speed, tested on a special testing machine before shipping, carefully examined by experts and when fitted with our patent safety collar, the chance of damage due to emery wheels breaking is reduced to the minimum.

Safety Emery Wheels are made from Emery, Corundum or Carbondite, are uniform in hardness, porous, free cutting and guaranteed not to deteriorate with time.

Catalogue 6-M on request.

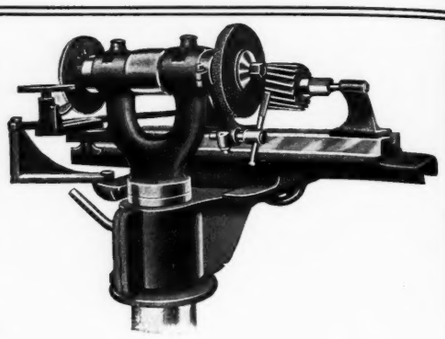
The Safety Emery Wheel Company
Springfield, Ohio

FOREIGN REPRESENTATIVES—Pfeil & Co., London V. Lowener & Co., Copenhagen. Adler & Eisenschitz, Milan. De Fries & Co., Act. Ges., Dusseldorf, Berlin, Wein and Paris. J R. Baxter & Co., Montreal, Canada.



The Wells

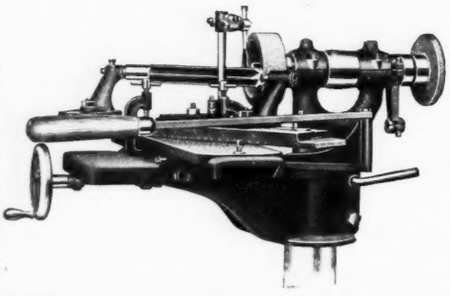
Grinder is designed for grinding all the ordinary sized tools.



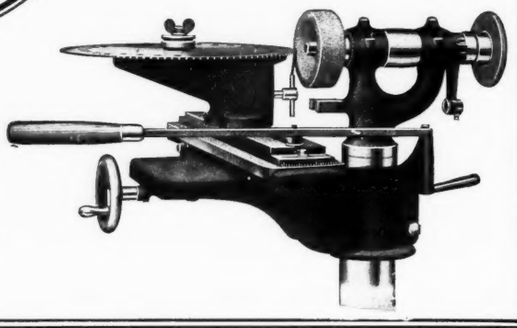
A separate **Wells Grinder** for each different kind of tool will save changing over every time.

F.E. WELLS & SON COMPANY
GREENFIELD MASS. U.S.A.

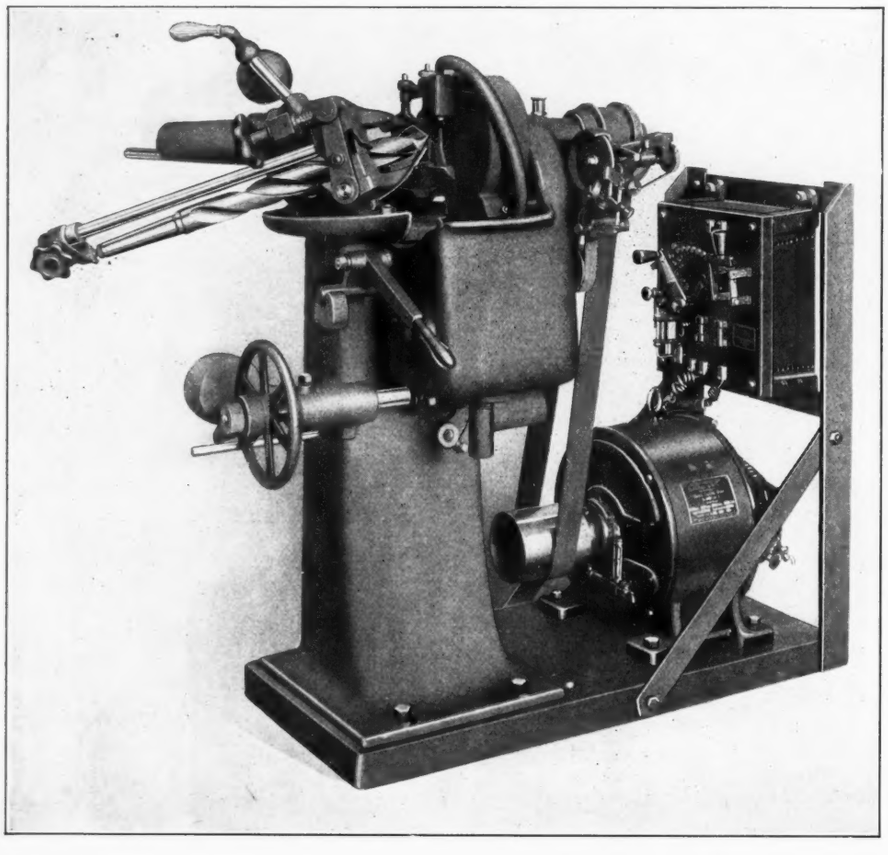
We will give you the equipment you want for your particular work. You don't have to pay for what you don't want.



The **Wells Grinder** has everything but large capacity, and for a much less price.



WILLIAM SELLERS & CO., Inc., Philadelphia, Pa.

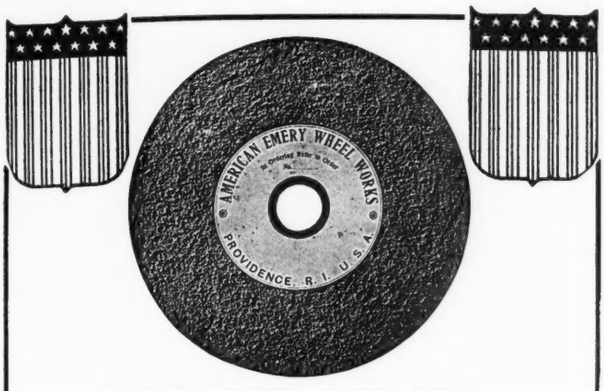


Labor Saving Machine Tools

Our Drill Grinding Machine is fully capable for drills from 1/8" to 3" diameter inclusive.

It is extremely simple, and does not require a mechanic to operate it.

Drills treated by it do much more and better work than when ground in any other way. It is therefore profitable to the purchaser.



DO YOU GRIND SOFT STEEL?

Read this letter from a prominent manufacturer, one who is an expert on grinding, and very particular in regard to grinding wheels.

3-10-09.

"Referring to the wheel recently shipped us, this wheel seems to cut better than any wheel that we have tried for some time, it is in fact, **the best wheel we have used on soft steel.** We do not think this is putting it too strong. The wheel cuts fast, cool, wears very little and seems to remain sharp."

(NAME ON APPLICATION.)

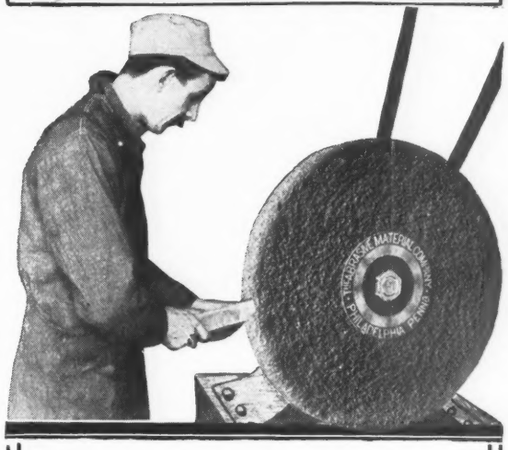
This wheel was 24″ dia., 3″ face and 12″ hole, was made of Pure Corundum, and used on a Landis grinder.

All of our wheels show the same high efficiency as the one described above.

If you are not using **AMERICAN** Corundum wheels or Emery wheels, you are not getting the best possible results in your grinding operations. Better order a trial wheel to-day. All sizes and shapes for all operations.

American Emery Wheel Works, Providence, R.I., U.S.A.

ABRASIVE



Fast Grinding Wheels

Bring relief to tired arms because they "take right hold" and rip off the surplus material without the necessity of pushing and straining as with most other wheels.

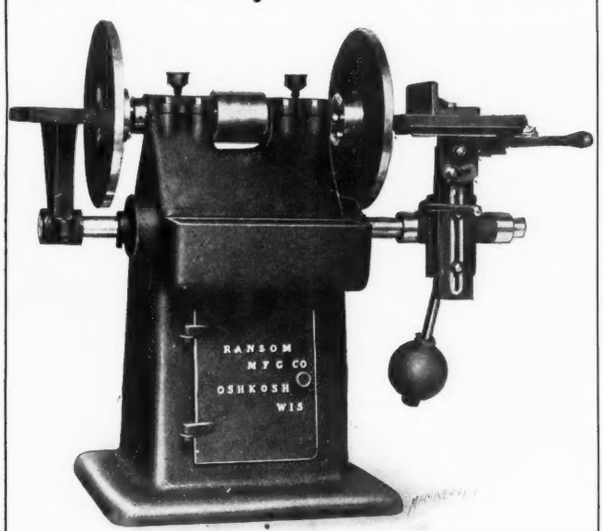
Ask any workman who has tried them, and see if he doesn't prefer them.

That's our strongest recommendation, for a mechanic will turn out more work with appliances he likes.

Let us send a trial wheel for experimental purposes—test this statement and see if we are not correct.

ABRASIVE MATERIAL COMPANY
PHILADELPHIA, PA.

Ransom 18" Style "L" Disc Grinder



Small flat surfaces can be finished faster on this machine than on the milling machine or shaper.

Write for particulars.

Ransom Mfg. Co., Oshkosh, Wis., U.S.A.

AGENTS: Ludw. Loewe & Co., Berlin, Germany, London, England.

Vitrified Wheels

For high speed steel tool grinding—
For the every day grinding of the shop—and
For the special "can't-do-it-too-carefully" piece of work that comes in occasionally.

Made from pure Corundum by the Vitrified Process, these wheels are fast, free and cool cutting, never glaze, are strong, safe and durable. Not a particle of non-cutting matter in the whole wheel. All grades and sizes.

The Vitrified Wheel Book is at your service.

Vitrified Wheel Company
Westfield, Mass.

"A PUTTING-ON TOOL"

The Davis-Bournonville Process

AUTOGENOUS WELDING
IS A
SCIENTIFIC ART

The Oxy-Acetylene flame will melt almost any metal, but the flame must be of *uniform chemical composition*, supplied *infallibly* under *constant pressure*, and applied with *intelligence*, to secure satisfactory results. Not only must the Torch be of *proper design*, but it *must be constructed* with the *utmost accuracy*. The Davis-Bournonville Torch is

A SCIENTIFIC TOOL

designed in accordance with *correct theory* and *practice*, made by *expert mechanics* and *tested most conscientiously* when finished.

WHAT IS THE USE

of buying Oxy-Acetylene Apparatus because it is cheap and then condemning the Process because of bad results? We have *replaced* a number of Plants because their *operation was unsatisfactory*. Several tests have recently been made by *prospective purchasers* of samples of welding by our Process and that of competitors, in which we have had much the better welds. In one of the cases

THIS IS THE RESULT

Comparative Test

3 Bars Machine Steel turned to .545 x 2" after welding

NATURAL STATE LBS. PER SQ. INCH	D-B WELD LBS. PER SQ. INCH	COMPETITORS' WELD LBS. PER SQ. INCH
Elastic Limit, 42,300	40,700	25,600
Tensile Strength, 59,200	51,000	25,600
Elongation in 2", 31%	10%	None
Reduction in Area, 52.7%	33.4%	None

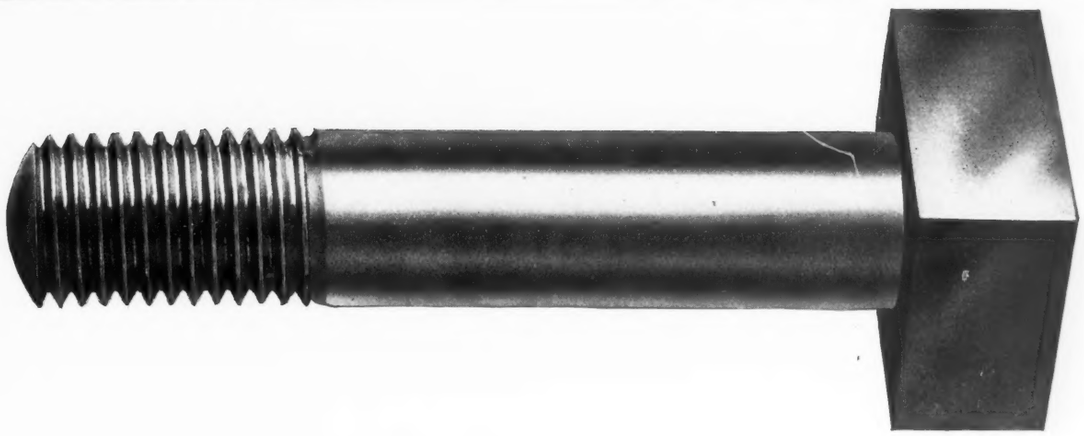
CAN ANY REDUCTION IN PRICE COMPENSATE FOR BAD RESULTS?

GENERAL DEALERS:

DAVIS-BOURNONVILLE COMPANY
97 WEST STREET, NEW YORK

General Dealers with Demonstrating Plants:

Chicago Welding Co., 34 West Quincy St., Chicago, Ill.
George Breck, 70 Turk St., San Francisco, Cal.
Autogenous Welding Equipment Co., 92 Hayden Ave., Springfield, Mass.
Autogenous Welding Devices Co., 602 East 15th St., Kansas City, Mo.
The Pneumatic Appliances Co., Singer Bldg., New York.
Davis Acetylene Co., Elkhart, Ind.
The Scobey Oxy-Acetylene Co., 190 Chapman St., Portland, Ore.
Henderson-Willis Welding & Cutting Co., 415 Walnut St., St. Louis, Mo.
Prentiss Tool & Supply Co., 145 Oliver St., Boston, Mass.
Whiteside Wheel Co., Canal and 10th Sts, Indianapolis, Ind.
Industrial Supply & Equipment Co., 407 Sansom St., Philadelphia, Pa.
Southern Welding & Machinery Co., Second St., Macon, Ga.



JUST A MINUTE NOW

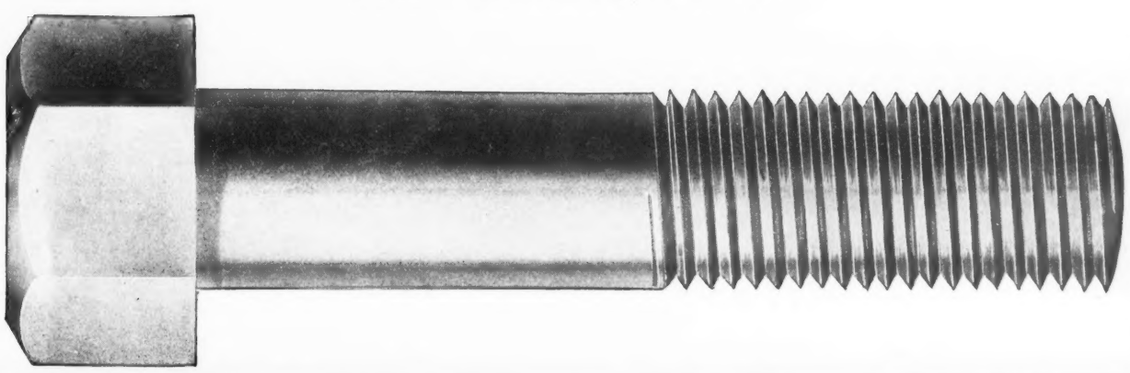
may later save you many minutes and dollars if you will only remember, when the making or buying of Large Screws comes up again, that you can secure this line from us, made from superior quality stock at attractive prices.

Remember that we make these Large Screws and Bolts by the electric welding process, which eliminates both waste of stock and labor. Remember, too, that we guarantee our screws to be accurate, stronger and better than any you have ever used—in fact we guarantee them to be satisfactory in every respect—you to be the judge.

Can anything be fairer than this, and can we now trust you not to forget us when in the market?

The Electric Welding Products Co.

CLEVELAND, OHIO



KEMPSMITH
MILLING MACHINES

Are the ideal selection

both to those shops using millers extensively in severe service for maximum production, as well as to those shops just beginning their installations and use of milling machines,

Because they are primarily heavy and powerful, substantial and strong to the smallest operative detail. They have fool-proof geared feed change and feed trip mechanism, and concentrated and simple operation. They are *safe*.

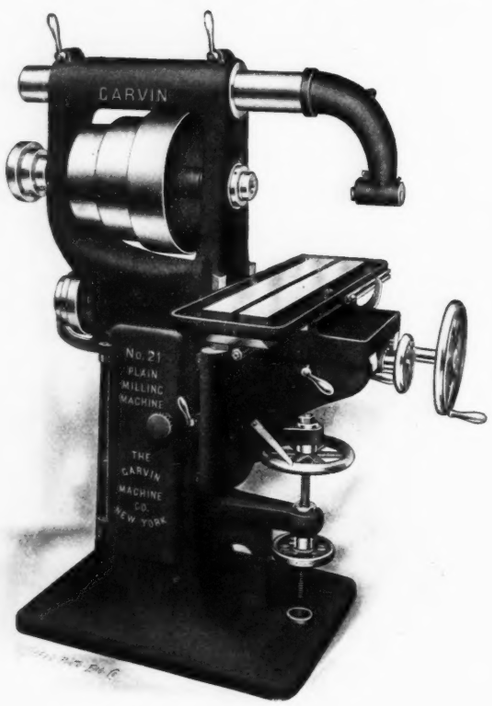
Built in a wide line.
Fully described in catalog.

THE KEMPSMITH MFG. COMPANY
Milwaukee, Wis.

European Agents: Selig, Sonnenthal & Co., London, E.C.
Canadian Agents: London Machine Tool Co., Ltd., Hamilton, Ont.

GARVIN
No. 21 PLAIN MILLING MACHINES

IMMEDIATE DELIVERIES



GARVIN No. 21 Plain Milling Machine.

Are used by some large concerns in batteries of SIX to ONE operator.

They are simple, plain and substantial, well built and sold for a moderate price.

The back geared machines are capable of doing a large amount of heavy, plain and gang milling for general manufacturing.

They have an automatic trip and a quick return by the large hand wheel and are equipped with our

SOLID TOP EXTENDED (PATENTED) KNEE

Get circular No. 87.

MANUFACTURED BY

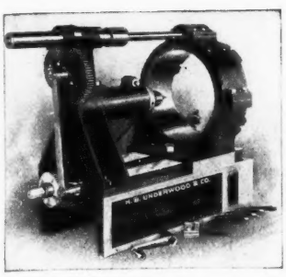
THE GARVIN MACHINE CO.
Spring and Varick Streets, NEW YORK CITY

Chicago, Pittsburgh, Detroit and Cleveland, Manning, Maxwell & Moore, Inc. Providence, The Brownell Machinery Co., 21 Exchange Place. Philadelphia, E. L. Fraser, 50 No. 6th Street. Boston, Thomas Crowther & Co., 170 Oliver Street. St. Louis, W. C. Johnson & Sons Machinery Co. Los Angeles, Smith-Booth-Usher Co., 212 So. Los Angeles Street. Syracuse, The C. H. Wood Co.

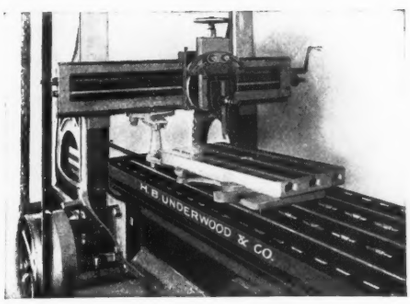
London and Glasgow, C. W. Burton, Griffiths & Co. Dresden, (A-3) and Berlin (C), and Leipzig, Haelbig, Wagner & Co. Milan, Teodoro Koelliker. Stockholm, Hugo Tillquist's Maskin, Agentur. Mexico, Manning, Maxwell & Moore, Inc. Vienna, Maschinen-Technisches Bureau, Ing. Rudolf Salzer.

UNDERWOOD PORTABLE TOOLS

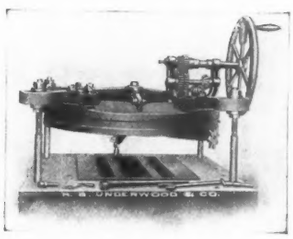
Time Savers for the Machine and Repair Shop



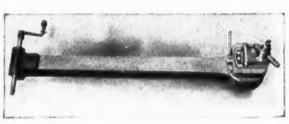
Portable Crank Pin Turner. Built in four sizes to take 20" and down



Radius Planer Attachment

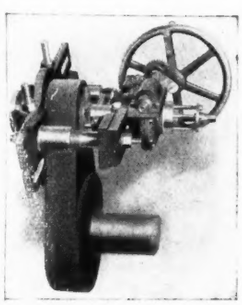


Rotary Valve Seat Facing Machine



Circular Planer Tool

Standard Lathe Boring Bar

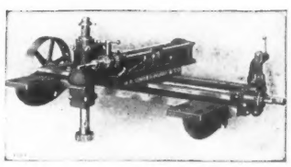


Crank Pin Rivet Head Facer

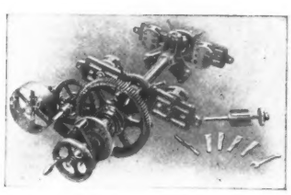
Take the Tool to the Work—

Don't disassemble a heavy machine when repairs can be made right on the spot. The Underwood line of Portable Tools covers a multitude of contingencies in repair work and will save incalculable time and labor on a wide range of general shop work. Designed by experts, these tools are simple in construction, strong, convenient, are rapid in operation, easily handled and very economical in the use of power.

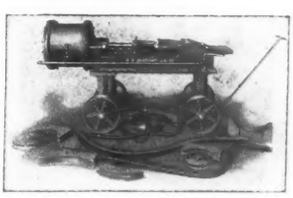
Write for 1909 Catalogue with detailed description of stock machines. Special Tools built to order.



Portable Milling Machine



Portable Cylinder Boring Bar



Portable Pipe Bender

H. B. UNDERWOOD & COMPANY

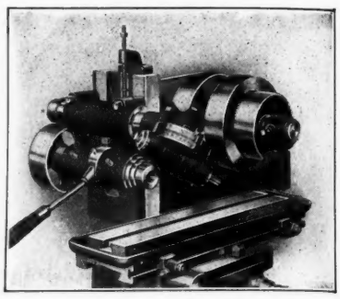
(L. B. FLANDERS MACHINE WORKS, EST. 1870)

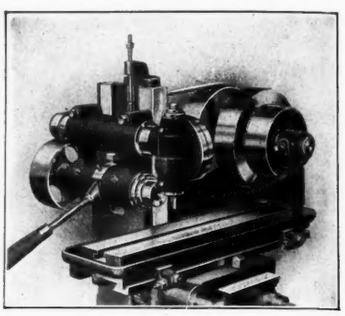
1025 HAMILTON STREET, PHILADELPHIA, PA.

This New Vertical Universal High Speed Milling Attachment makes the

"Whitney" Hand Miller

one of the most complete and desirable tools on the market for a wide range of work.

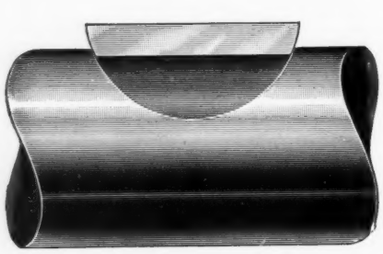


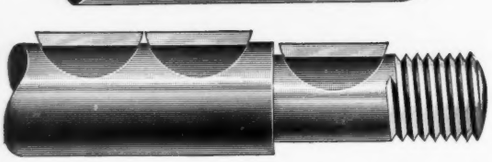


USE THE

"Whitney" High Grade Driving Chains

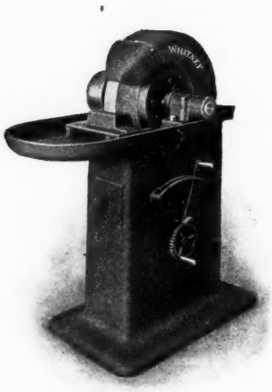
For Machinery, Automobiles, Motorcycles, Bicycles, etc.





The "Whitney" 20-Inch Tool Grinder

is popular on account of Efficiency, Simplicity, Quality, Finish and Price.



If you are not taking advantage of the

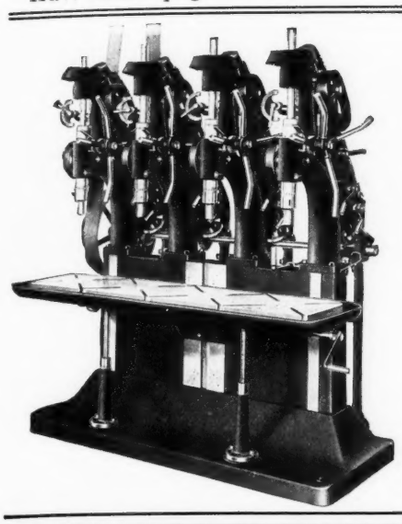
Woodruff Patent System of Keying

it will pay you to investigate.

Better results and a great saving in cost.

The Whitney Mfg. Co.

HARTFORD, CONN.



An All Geared 20-in. Gang Drill

MR. B. F. BARNES.

This Gang Drill has no cone belts—just one main driving belt. Each spindle has **Geared Speed Transmission** and **Positive Power Feeds,** from .001" up to .025", all under instant control of operator. Any spindle may be instantly stopped or started independent of all other spindles. No time is lost in chasing around machine to shift speed and feed belts or in stopping to lace and replace them in the old way.

The use of this All Geared Gang will mean big savings in your belting expense, and still larger savings in **time,** besides, it will properly handle much heavier work than any cone driven gang of same swing. Drills up to 1½" in steel and taps 2" in cast iron.

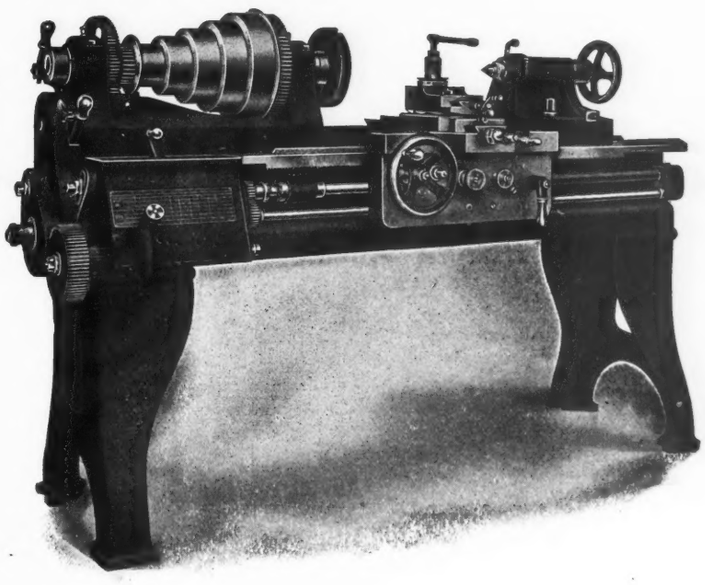
Ask for descriptive circular and prices.

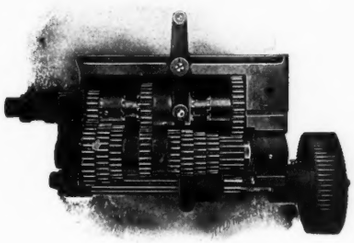
BARNES DRILL CO., Incorporated 1907
602 S. Main St., Rockford, Ill.

The Flather Quick Change Gear Lathe

Latest and Best.
Strong and Simple.
Greatest number of
Threads and Feeds.
Least number of Gears.

Send for descriptive circular.



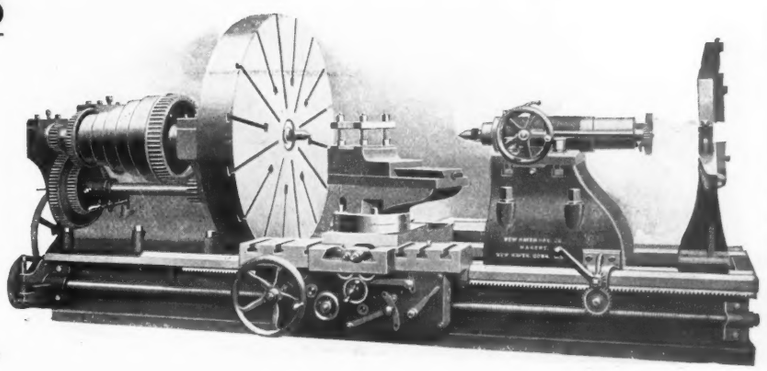


Flather & Company, Incorporated, Nashua, N. H.

NEW HAVEN TOOLS

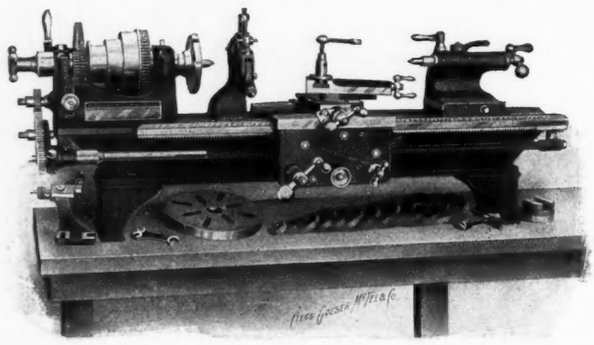
Triple Geared Engine Lathe
60-inch Swing

One of the strongest and most powerful lathes on the market. Fifteen changes of speed. All conveniences for operation. Bed wide and deep and strongly braced and can be furnished in lengths from 16 to 36 feet.



New Haven Mfg. Co.
New Haven, Conn.

9-inch "Star" Bench Lathe



A strong, accurate screw cutting lathe particularly adapted for the tool-room and the finer grades of lathe work. It is a "Star Special" and a special Star for model, electrical, experimental—precision work of all kinds. It is very complete, has full line of attachments and covers a wide range of work.

The price is so low it is quite out of proportion with the quality given but the gain is yours.

Catalog B for full description.

The Seneca Falls Mfg. Co.
330 Water St., Seneca Falls, N. Y., U. S. A.
148 A

If it's Dollars You Want
don't try to make your own

RACK

TELL YOUR RACK
TROUBLES TO US.

R A C K

R A C K

We are
Rack Specialists

Our Catalogue B will tell you about it.
Write for it.

Hall & Pickles,
64 Port St., Manchester, Eng.

Pacific Tool & Supply Co.,
San Francisco, Cal.

Seattle Hardware Co.
Seattle, Wash.

ROGERS REAMERS

Solid and Adjustable Blade

We make a specialty of Adjustable Blade Reamers and carry a full line of leading sizes in stock.

The accuracy, simplicity and durability of Rogers Tools is too well established to need reiteration and the economy of the Adjustable Blade Reamer speaks for itself.

Write for new list of High Speed Reamers and Catalogue No. 7.

THE JOHN M. ROGERS WORKS, GLOUCESTER CITY, N. J.

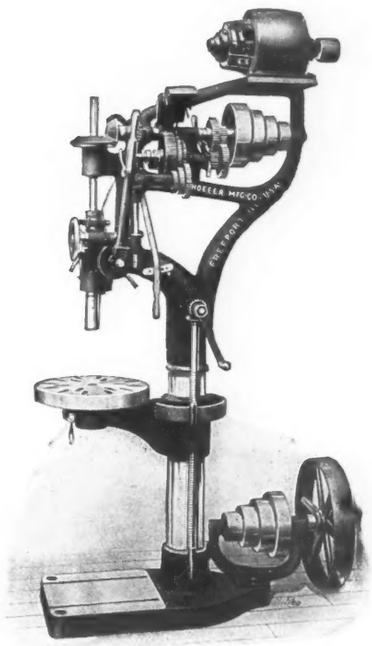
FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, E. C. Selig, Sonnenthal & Co., London, E. C. C. W. Burton, Griffiths & Co., London, E. C. DeFries & Co., Dusseldorf, Germany. V. Lowener, Copenhagen, Denmark. J. E. Chabert & Co., Paris, France.

HŒFER DRILLING MACHINES

The wheels of industry are turning again, with nearly full force in our factory. Why? Because buyers everywhere have placed their confidence in our product.

We are building more drills and better drills than before, because we have prepared ourselves for it.

Send for new Catalog "M."



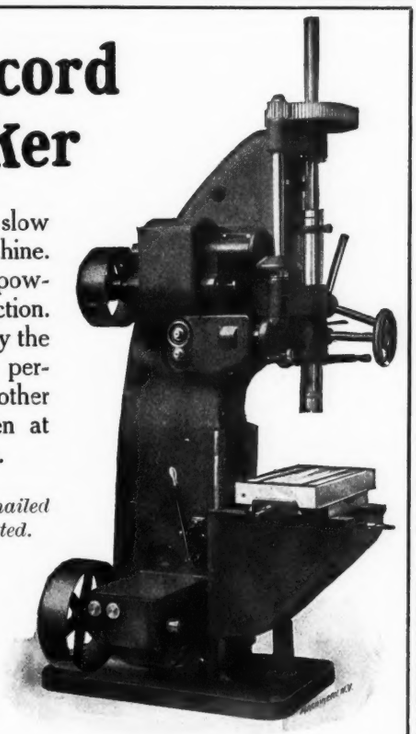
HŒFER MFG. CO. FREEPORT, ILLINOIS, U. S. A.

AGENTS:—For Great Britain, C. W. Burton, Griffiths & Co., London; for Sweden, Axel Christiernsson of Stockholm, Malmo and Gotenborg; for Finland, Axel Christiernsson Abo; for Switzerland, J. Lambercier & Cie, Geneva; for France, Mestre & Blatge, Paris; for Spain, Mestre & Blatge, Madrid; for Austria, Blau & Co., Vienna; for Victoria, Australia, Bevan & Edwards, Propt. Ltd., Melbourne; for New South Wales, Australia, R. S. Scrutton, Sydney; for Queensland, McLennan & Co., Brisbane.

A Record Breaker

Nothing very slow about this machine. It's simple, yet powerful in construction. Does every day the work usually performed by other machines when at their best tests.

Our Catalogue mailed to those interested.

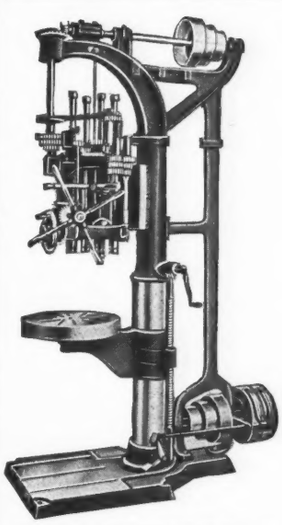


1¼" Hole 29 Inches Per Minute

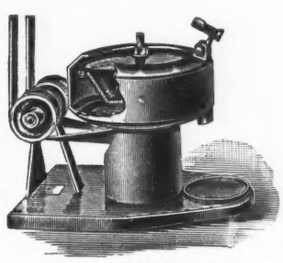
BAKER BROTHERS

Toledo, Ohio, U. S. A.

FOREIGN AGENTS: Schuchardt & Schutte, Berlin, Vienna, Stockholm. A. H. Schutte, Cologne, Paris, Brussels, Liege, Milan. Chas. Churchill & Co, London, Manchester.



The Cylinder-Turret Drill Press.



Combined Oil Separator and Filter.

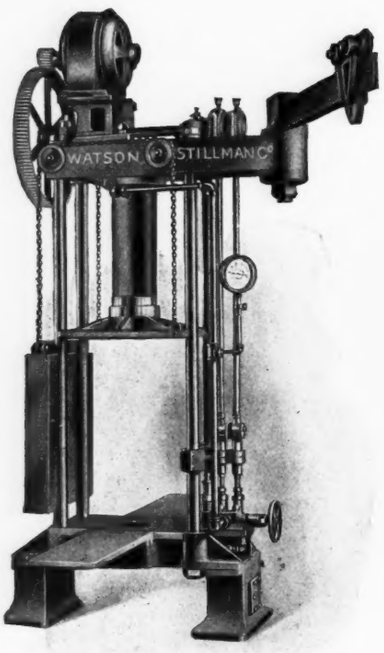
Exclusive Features Of the Cylinder-Turret Drill Press

Rigid and durable; no strain on the turret; different speeds for different spindles; only the spindle in use moves; perfect and permanent alignment and only enough power required to do the work.

Write for our 30 day free trial offer and also particulars concerning our Oil Separator and Filter.

National Separator and Machine Co.

Boston, Mass.



Watson-Stillman Hydraulic Presses

are built for convenience as well as service. Take, for instance, the reversed cylinder forcing press shown. The crane on the top saves a lot of trouble in handling heavy pieces, and the two shelves extending out from the side of the piston are very handy to set work on before pushing it into the press. If the shelves are in the way they can be removed.

Watson-Stillman presses are built in many types and sizes and in capacities up to 4,000 tons. If our large line does not contain what you want, we will build to order on short notice and at reasonable price.

If interested in assembling or forcing presses, write for Catalog No. 70. If interested in other hydraulic tools, tell us your requirements and we will quote prices.

THE WATSON-STILLMAN CO.

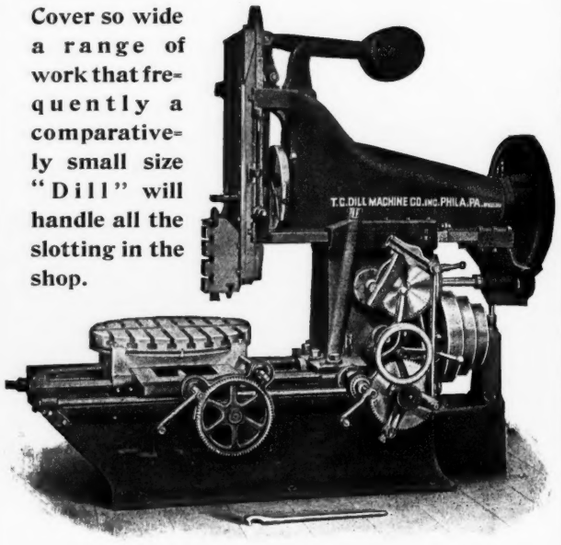
Builders of Hydraulic Tools for Every Purpose

192 FULTON ST. NEW YORK

CHICAGO: 453 THE ROOKERY

DILL SLOTTERS

Cover so wide a range of work that frequently a comparatively small size "Dill" will handle all the slotting in the shop.

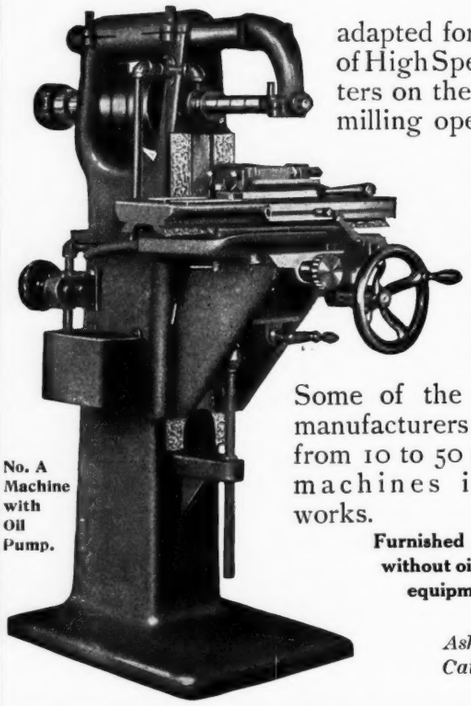


The traveling head practically makes a big slotter of a little one. It permits the machining of the outside of large circles; when a piece is too heavy or cumbersome to be fed to the machine, it can be held stationary and the head fed along instead. Other advantages, too, which are fully described in the catalogue—may we send a copy?

THE DILL SLOTTER PEOPLE

KENSINGTON, PHILADELPHIA, PA.

Van Norman No. A and No. AA Plain Milling Machines for Rapid Manufacturing



No. A Machine with Oil Pump.

adapted for the use of High Speed Cutters on the lighter milling operations.

High Grade Rapid Cutting with Quick Return

Some of the leading manufacturers have from 10 to 50 of these machines in their works.

Furnished with or without oil pump equipment.

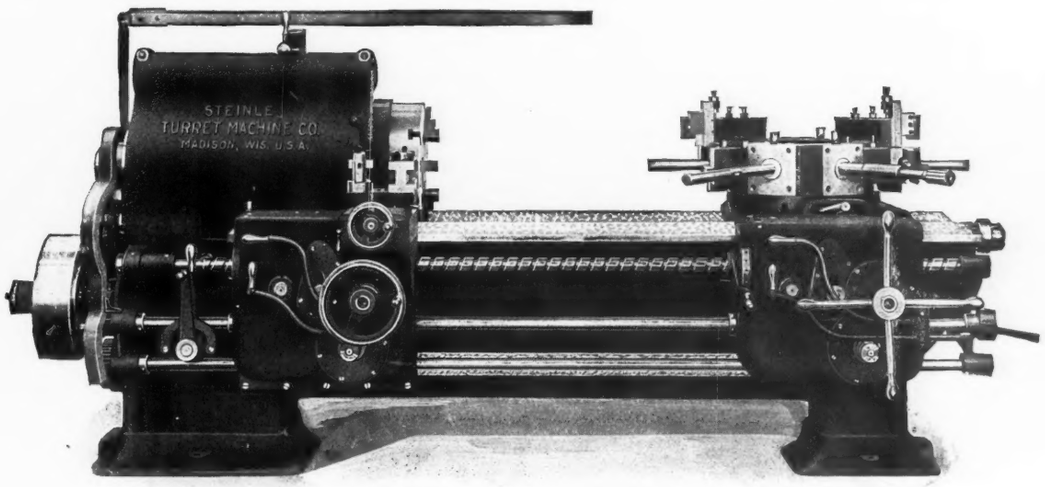
Ask for Catalog.

WALTHAM WATCH TOOL CO.

SPRINGFIELD, MASS., U. S. A.

THE FULL SWING TURRET LATHE

Increased Capacity - Short Turret Tools - Modern in All Details



STEINLE TURRET MACHINE COMPANY

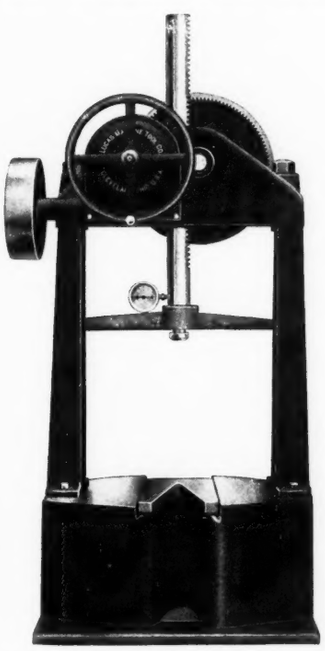
MADISON, WIS., U. S. A.

SELLING AGENTS.

MANNING, MAXWELL & MOORE, Inc., New York.
Atlanta, Boston, Chicago, Cleveland, Detroit, Milwaukee, Philadelphia, Pittsburg, St. Louis, Syracuse, Seattle, Portland, Japan, Mexico.

LUDW. LOEWE & CO., A. G., Berlin.
Austria, Belgium, Denmark, France, Germany, Holland, Hungary, Italy, Norway, Romania, Russia, Spain, Sweden, Switzerland.

"THE MAN WHO DOESN'T PUSH HIS BUSINESS IS LIKELY TO BE PUSHED OUT OF BUSINESS"



There are lots of things that can be pushed to where they belong better with a

LUCAS
Power Forcing Press

than with anything else ever made.

THE BELT DOES THE WORK.

The man applies, controls, graduates and releases the power, makes all the adjustments and does everything he has to do to operate the press

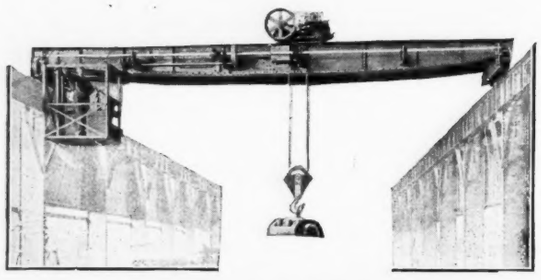
ALL WITH ONE WHEEL.

Does the most pushing at the least expense.

LUCAS MACHINE TOOL COMPANY, Cleveland, Ohio, U.S.A.

EUROPEAN AND AUSTRALIAN AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest. E. McCray & Co., Sydney, Australia.

Cleveland Cranes are Good Cranes



They're made from *good* material by a *good* concern, and they're guaranteed to do *good* work. The reports of their efficiency, reliability and durability are all *good*, too. We also have a *good* catalog that shows some of the *good* work these hoists are doing.

THE CLEVELAND CRANE & ~~CAR CO.~~ ENGINEERING CO.
WICKLIFFE, OHIO.

SHAW ELECTRIC TRAVELING CRANES

Gantry Crane installed at Freight Terminal, Boston, of the N. Y., N. H. & H. R. R. Co., by THE SHAW ELECTRIC CRANE CO., main hoist 35 tons, auxiliary hoist 5 tons, span 55 feet.

THE SHAW ELECTRIC CRANE CO.

Manufacturers of

Jib
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Wharf
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Special
Transfer
Cantilever
CRANES

Never Buy a Crane Before Investigating the Shaw

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TWO SCORE YEARS AND MORE

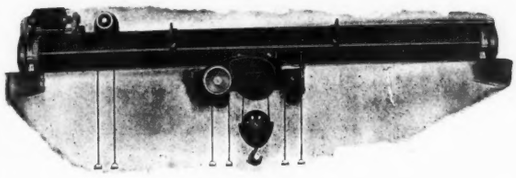
Our wide experience, covering a period of over two score years, has taught us how to build the right sort of cranes for the particular service required of them.

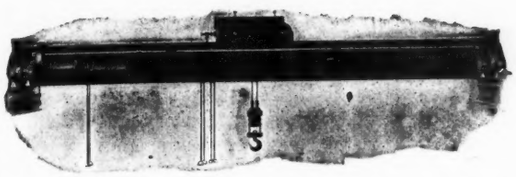
Thus you secure the best results—the highest efficiency in service, the greatest economy in operation and maintenance. It's because of such experience that we can back up our statement that

P. and H. Cranes are Right

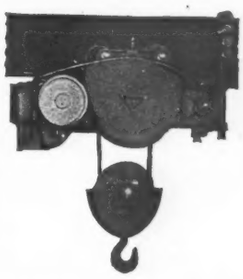
Ask Dept. M for information about cranes for your particular work.

PAWLING & HARNISCHFEGER
Milwaukee, Wis.





TWO useful little Electric Traveling Cranes and a compact Electric Trolley Hoist are here shown. They are among our regular designs and should interest anyone wanting reliable cranes or hoists of any capacity. A request will bring prices.



NORTHERN ENGINEERING WORKS
DETROIT, MICH., U. S. A.

New York, 120 Liberty Street Chicago, 539 Monadnock Block

The Efficiency
of the Triplex Block

NEARLY all the effort exerted on the hand chain, is transformed into hoisting energy in Triplex Blocks because of the "planetary action"

The internal gear acting at a large radius allows of large intermediate gears which give perfect contact of gear teeth and the minimum loss of energy in friction.

This elimination of friction means slight wear which causes Triplex Blocks to maintain their efficiency long after blocks of other designs are worn out.

The Triplex Block is made in 14 sizes, with a lifting capacity of from ½ to 20 tons. Other types are the Duplex: 10 sizes; ½ to 10 tons. The Differential: 7 sizes; ⅛ to 3 tons. The Electric Hoist: 10 sizes; ¼ to 16 tons. Y. & T. Blocks are carried in stock by Hardware, Machinery and Mill Supply Dealers. Catalog with interesting technical information on request.

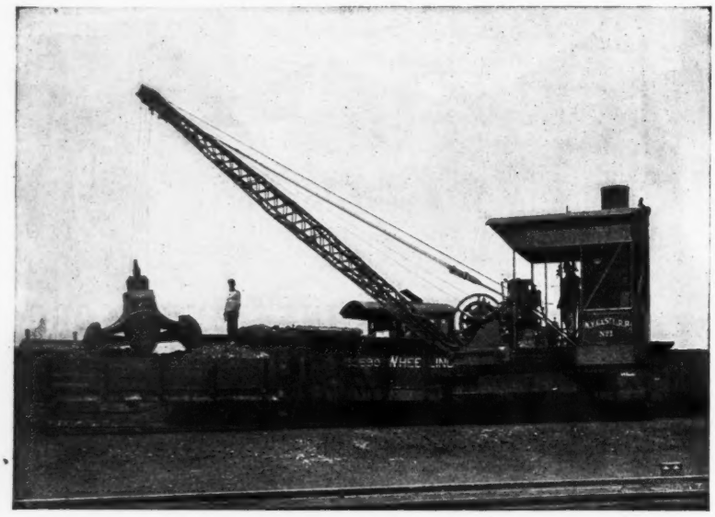
THE YALE & TOWNE MFG. CO., 9 Murray St., New York

DA 2.

FOR IMMEDIATE SHIPMENT

24" standard planers to plane 6' and 8' long with one head on cross rail.

POWELL TOOL CO., Worcester, Mass.

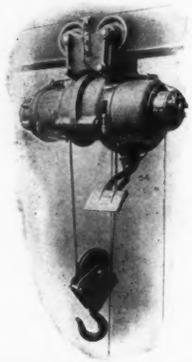


THE BROWN HOISTING MACHINERY CO.

Engineers, Designers and Manufacturers of Hoisting Machinery of all descriptions

MAIN OFFICE AND WORKS: CLEVELAND, OHIO, U. S. A.

Branch Offices: Pittsburgh and New York.



Shepard Electric Hoists

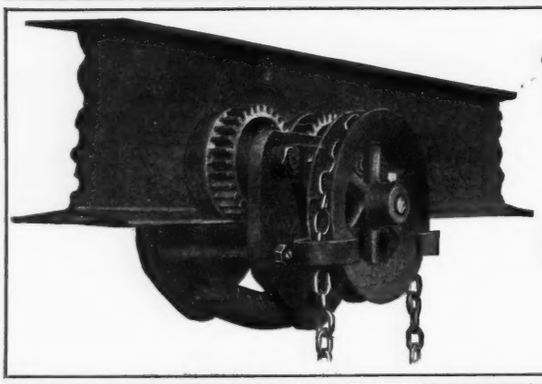
ARE
DEPENDABLE
DURABLE and
ACCURATE

Capacities 500 to 20,000 lbs.

Shepard Electric Crane & Hoist Company

General Offices and Works, Montour Falls, N. Y.

New York. Philadelphia. Pittsburgh. San Francisco.
Toronto. Montreal



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MARIS BROS.

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PA.

ONE TO TEN TONS

PNEUMATIC GEARED HOISTS

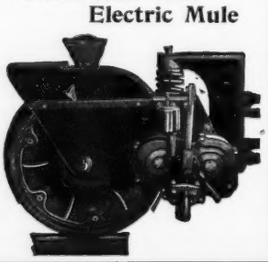
and other labor saving compressed air appliances.

Durability and efficiency guaranteed.

DETROIT HOIST AND MACHINE CO.

Successors to PILLING AIR ENGINE CO.
DETROIT, MICH.

Locomotive Turntable Pneumatic and Electric Mule



CRANES AND HOISTS

All Types and Capacities

We make a specialty of

HAND POWER CRANES

designed to receive motors at any time for a minimum outlay.

ALFRED BOX & CO.

Philadelphia, Pa., U.S.A.

Hercules Portable Crane and Hoist

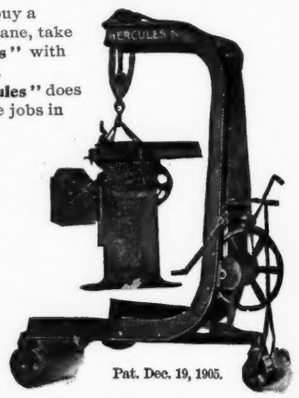
The Modern Model

When you buy a Portable Crane, take a "**Hercules**" with Steel frame. The "**Hercules**" does all the crane jobs in the quickest, easiest way, with least labor.

Standard Sizes.

Specials to Order.

Circular on request.



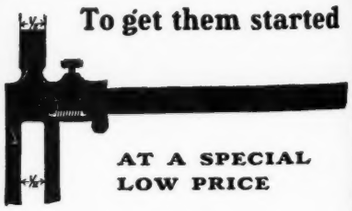
Pat. Dec. 19, 1905.

William S. Nicholls, 254 Broadway, New York

Two in One

Calipers No. 15

To get them started



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Write today

E. G. SMITH CO.

Columbia, Pa.

OUR SPECIALTY,

Automatic Machinery for making Wood Screws,

Asa S. Cook Co., HARTFORD, CONN., U. S. A.

The Peerless Hoist

The latest type of spur geared hoist embodying special features that make it the most efficient device of its class.

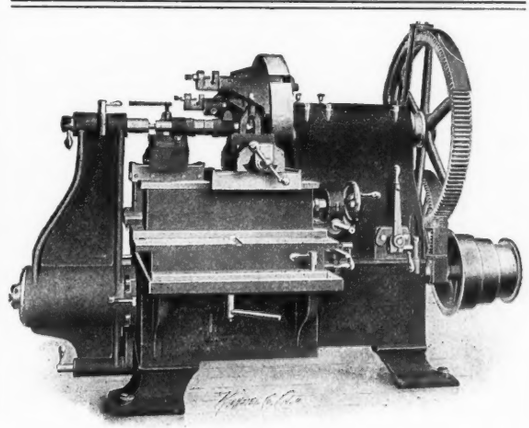
Safety, Durability Speed and Power

are prominent characteristics of the "Peerless"—all qualities that go to make up the perfect hoist. The single load chain tends to light weight and compact form; all working parts are protected by dust proof cases; the hoisting mechanism—a train of compound balanced steel gears—insures smooth action and reduces wear to the minimum; and all danger of the load slipping is eliminated by a chain guide and stripper.

We shall be glad to furnish full particulars on request.

Edwin Harrington, Son & Co., Inc.
Philadelphia, Pa., U. S. A.

STREIT PULLEY LATHE



Roundabout Methods *vs.* Short Cuts

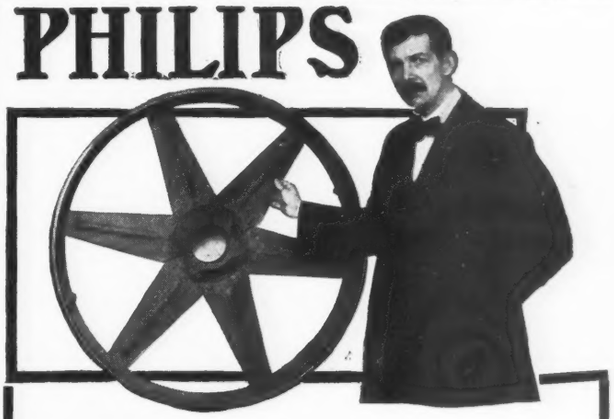
Which do you believe in?

If you have many pulleys to turn, why should you do the work in a roundabout way on a general purpose lathe which has many features that are not adapted to turning pulleys? Why not use the machine that is built for this particular class of work, whose every feature is a time saver and essential to the work?

Speed and Accurate Work

The Cincinnati Pulley Machinery Co.
Second Street, Cincinnati, Ohio, U. S. A.

PHILIPS



This is the Spider that

has helped make the great reputation of Philips Pressed Steel Pulleys.

We say helped because it's only one of the big advantages, for instance: there are the features of the face, the hub, the rim lug, etc., but in this ad. we're just talking

About the Spider

Read these:

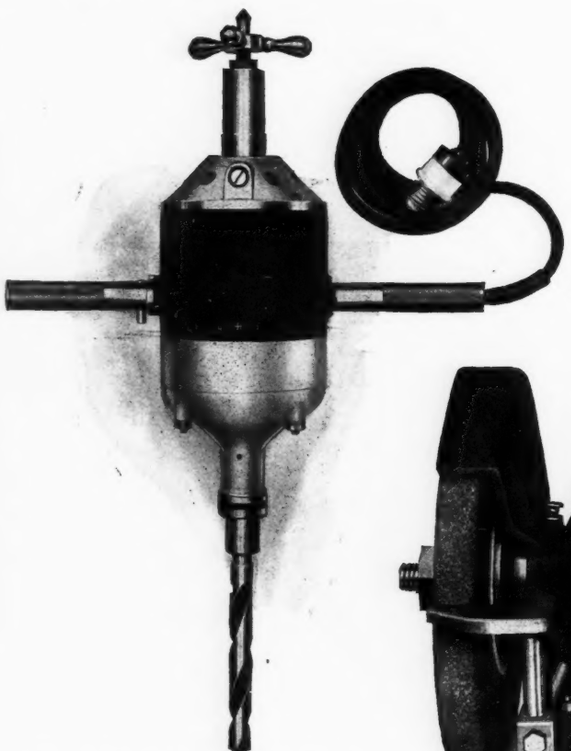
1. Made of heavy sheet steel.
2. Corrugated.
3. Strain must be distributed over entire circumference of the pulley rim with Philips Spider, for arms are of bridge construction.
4. Impossible to center strain upon any one set of arms.
5. Riveted to both sides of hub, spider arms reinforce outer edges of rim.
6. Sheet steel construction offers minimum resistance to air.

If this one feature doesn't convince you conclusively, drop us a postal today and we'll tell you all about it.

Philips Pressed Steel Pulley Works
Fourth St. and Glenwood Ave.
PHILADELPHIA, PA.

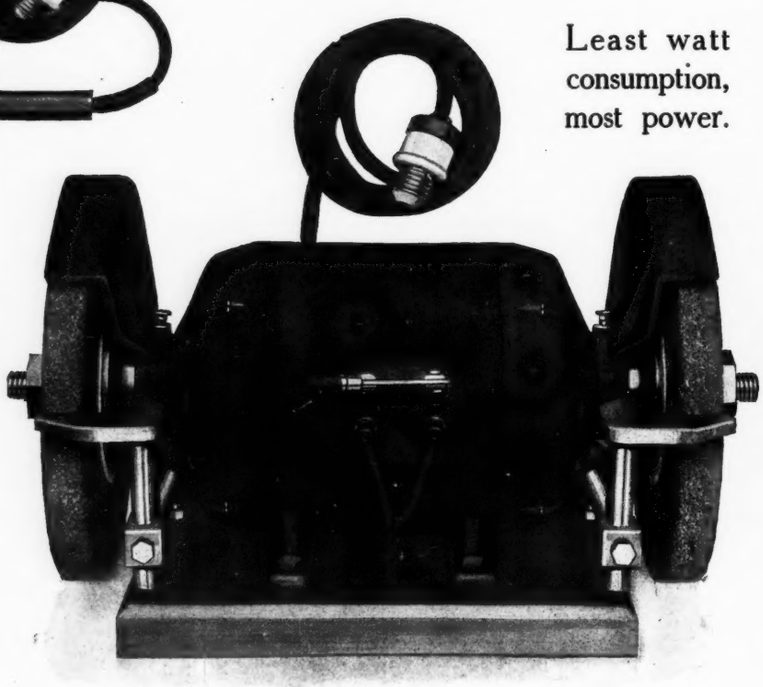
THE IMPROVED "HISEY" PORTABLE ELECTRIC TOOLS

Are sent anywhere on trial to prove their greater efficiency



Drills for every purpose—Hand, Breast, Screw Feed and Radial Types, from 1-4" to 2" capacity.

Least watt consumption, most power.



Center, Tool-post, Bench, Aerial, Internal Grinders and Buffers suitable for every class of work.

All motors entirely enclosed, absolutely dust-proof, air-cooled. Brush-holders, lead-wires, all connections enclosed, preventing short-circuiting. Brushes removable without disturbing any other parts. All bearings adjustable to wear. Drills provided with our new patented enclosed Automatic Switch. All gears separately encased, running in grease, not oil. Every Tool guaranteed up to its rated capacity.

All tools wound for direct or alternating current. Direct current for any voltage up to 600, alternating current for any voltage up to 440, single, two or three phase.

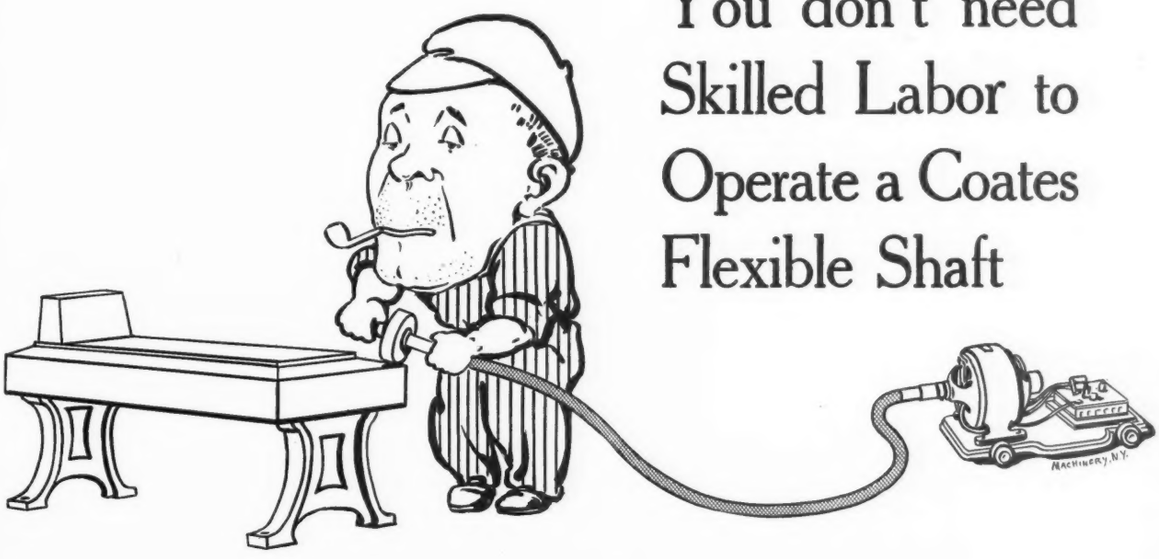
NEW CATALOGUE NUMBER SEVEN.

THE HISEY-WOLF MACHINE COMPANY

CINCINNATI, OHIO

NEW YORK OFFICE: 50 Church Street **BOSTON OFFICE: 10 Oliver Street**

FOREIGN REPRESENTATION: Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg. J. Lambercier & Co., Geneva. K. Lund & Co., Christiania. Wilh. Sonesson & Co., Malmo. Fenwick Freres & Co., Paris, Barcelona, Brussels. Ing. A. Baldini & Cie, Pontedera. Mitsui & Co., Tokio. Thomas McPherson & Sons, Melbourne. Philip G. Roeder, Mexico City.



You don't need Skilled Labor to Operate a Coates Flexible Shaft

The COATES

is so easy to manage it almost runs itself. Put the motor where it's handiest—up or down, or around the corner—put the odd man on the job and "let her go."

With the Coates Patent Multiplier, a grinding speed of 21,000 R.P.M. can be obtained for emery wheels up to one inch diameter—8 1-2 times the regular speed of the shaft. Figure that up against present methods of finishing metal patterns, pressed steel work, or drop forgings. Consider, too, the advantage of taking the outfit to the work—not the work to the grinder.

More good points about it, if you will ask us.

Coates Clipper Manufacturing Company

WORCESTER, MASS., U. S. A.

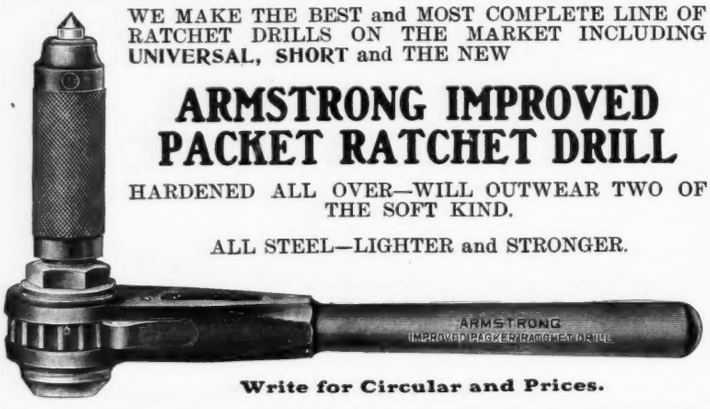
ARMSTRONG TOOL HOLDERS

The World's Standard Lathe and Planer Tools

NOTE extra large tool steel set screw and REINFORCED support under the cutter

THEY GIVE INCREASED CAPACITY AND LASTING QUALITY.

Make One lb. of Tool Steel Equal Ten lbs. in Forged Tools.



WE MAKE THE BEST and MOST COMPLETE LINE OF RATCHET DRILLS ON THE MARKET INCLUDING **UNIVERSAL, SHORT** and THE NEW

ARMSTRONG IMPROVED PACKET RATCHET DRILL

HARDENED ALL OVER—WILL OUTWEAR TWO OF THE SOFT KIND.

ALL STEEL—LIGHTER and STRONGER.

Write for Circular and Prices.

IMPROVED DROP FORGED "C" CLAMPS

BIGGEST LINE MADE

11 SIZES

HAVE LONG HUB and EXTRA HEAVY TOOL STEEL SCREW. ARMSTRONG QUALITY.

Write for Prices.

A NEW TOOL—A GOOD ONE—SOMETHING YOU NEED

YOU'LL WONDER HOW YOU GOT ALONG WITHOUT IT.

Patented, June 16, 1908.

The handle or driver is always ready to strike a blow as the spring automatically throws it back into position.

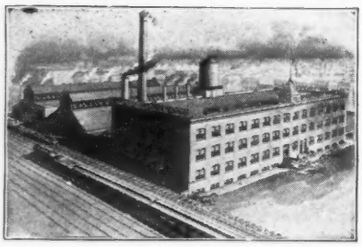
Write for Circulars and Prices.

ARMSTRONG AUTOMATIC DRILL DRIFT

ONE HAND to operate the drift and one to save the tool.

IT IS DRIFT and HAMMER COMBINED and with it a one handed man can beat a two handed man without it.

A two handed man using it as shown in cut will soon save time and tools enough to repay its cost.



Do you want our new catalog? It's a Tool Holder Encyclopedia.

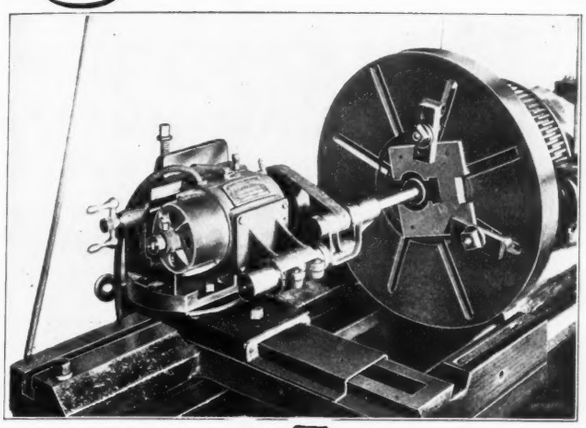
Armstrong Bros. Tool Co.

"THE TOOL HOLDER PEOPLE"

113 N. Francisco Avenue, CHICAGO, U. S. A.

Imitations are Unsatisfactory ::: Infringements are Unlawful

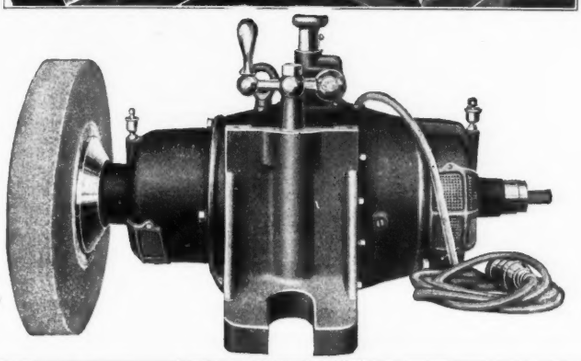
US ELECTRIC GRINDER—18,000 R.P.M.



For internal grinding such as dies, journal, engine cylinders, or internal grinding of any kind. Made in three sizes to grind up to 18″ deep. Grinding attachment can be taken off for external grinding such as center, cutters, rolls or grinding of any kind, on lathe, planer or boring mill. Emery wheel for external grinding 4½″ to 12″ in diameter.

Why not buy a combination electric grinder when you buy. Direct or alternating current.

SENT ON TRIAL



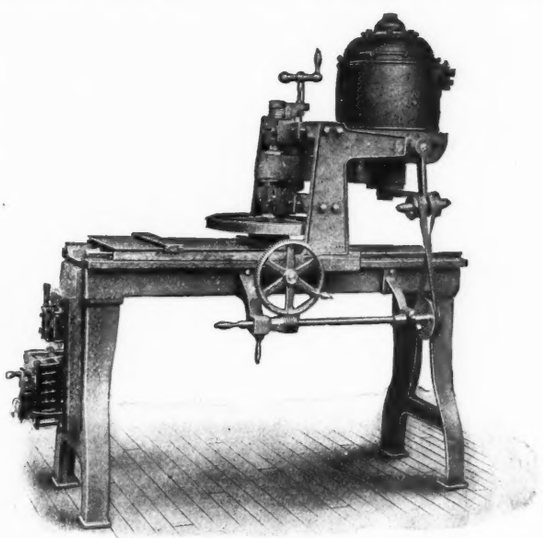
3 H.P. ELECTRIC GRINDER

For heavy grinding, on lathe, planer or boring mill. Wheel 14″ x 2″ motor air cooled. Also make electric drills.

Write for Catalogue.

The United States Electrical Tool Co.
CINCINNATI, OHIO, U. S. A.

Avoid Costly Shutdowns



Hawthorn Vertical Motor operating Daniels Planer.

The amount of work turned out in a day determines the efficiency of your plant.

Motors that will keep your machines in operation twenty-four hours in every day, if necessary, are the kind that keep your plant efficiency and its output at a maximum.

Hawthorn Motors are rugged, strong and reliable. They are conservatively rated and will carry their full loads twenty-four hours every day if called upon to do so.

By equipping your machines with **Hawthorn Motors** you are assured of their continuous operation.

Write for our Bulletin No. 505 on Direct Current Motors.

WESTERN ELECTRIC COMPANY

EASTERN
New York
Philadelphia
Boston
Pittsburg
Atlanta

CENTRAL
Chicago
Indianapolis
Cincinnati
Minneapolis

WRITE OUR NEAREST HOUSE

WESTERN
Saint Louis
Kansas City
Denver
Dallas
Omaha

PACIFIC
San Francisco
Los Angeles
Seattle
Salt Lake City

Northern Electric and Manufacturing Co., Ltd., Montreal and Winnipeg

BEST BY EVERY TEST

And Service Test is the Best

Wherever our **Portable Electrically Driven**

Drills and Grinders

have done service they have proven their efficiency.

Our Tools are AIR-COOLED and do not get hot.

DON'T FORGET THIS when considering Electric Tools.

The Drills are made in 9 sizes—3-16", 1-4", 3-8", 1-2", 3-4", 1", 1 1-4", 1 1-2" and 2 1-4".

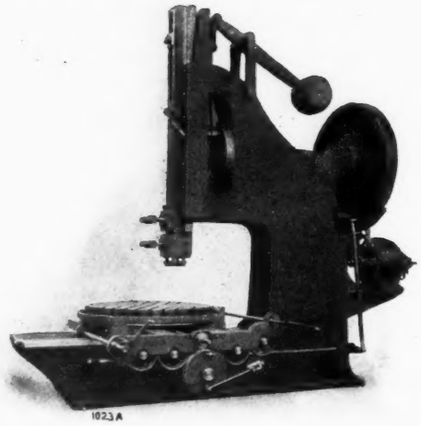
The Grinders are made in all sizes from 1-4 H.P. to 2 H.P. motor.

Let us send one on trial.
Send for Catalogue.

The Cincinnati Electrical Tool Company

CINCINNATI, OHIO, U. S. A.

FORT WAYNE



Northern Type Motor driving Betts 24-inch Slotter

We Are Pioneers

in the manufacture of machine tool motors. We have built motors to operate all kinds of tools. It has always been our specialty.

Fort Wayne Adjustable Speed Motors

embody the latest practice in motor design. They're as good as modern engineering can make them. Have wide speed adjustment and respond quickly to field regulation. Have great overload capacity. Low temperature rise. Simple, compact, sturdy and easily applied to most any mechanism.

May we send you our Bulletin 1111K?

Fort Wayne Electric Works

Main Office: Fort Wayne, Ind. **Factories: Fort Wayne, Ind. and Madison, Wis.**

SALES OFFICES

Atlanta
Boston
Chicago
Cincinnati
Grand Rapids
Madison
Milwaukee
New Orleans
New York
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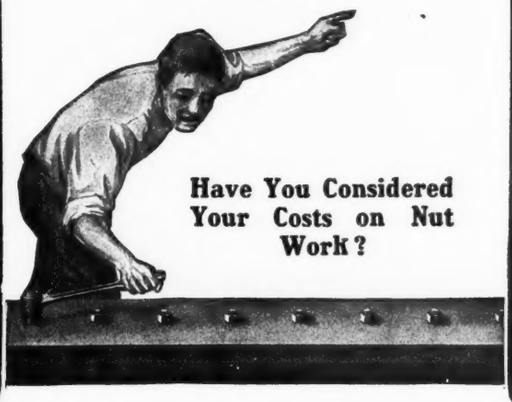
Pittsburg
San Francisco
Seattle
St. Louis
St. Paul
Syracuse

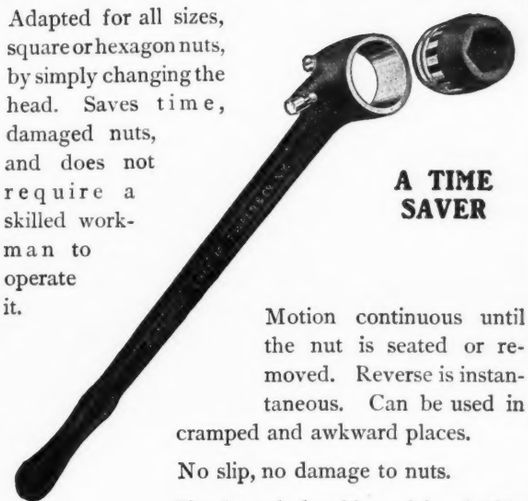
814

THE FAVORITE REVERSIBLE RATCHET WRENCH



Have You Considered Your Costs on Nut Work?

Adapted for all sizes, square or hexagon nuts, by simply changing the head. Saves time, damaged nuts, and does not require a skilled workman to operate it.



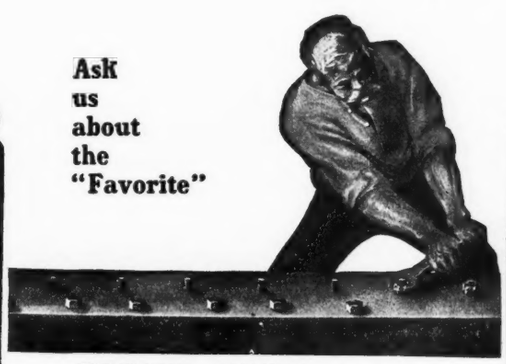
A TIME SAVER

Motion continuous until the nut is seated or removed. Reverse is instantaneous. Can be used in cramped and awkward places.

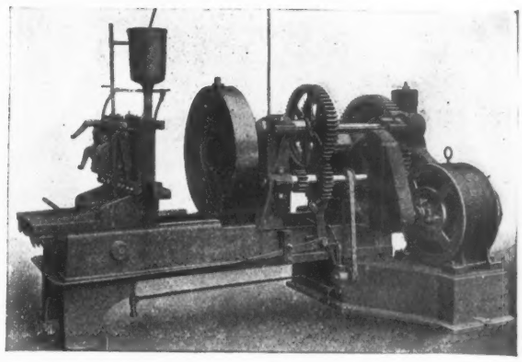
No slip, no damage to nuts.

Simple and durable and invaluable for railroad work—or any service where quantities of nuts must be handled.

Ask us about the "Favorite"



GREENE, TWEED & CO.
Sole Manufacturers
109 DUANE ST., NEW YORK



Westinghouse Motor Driving Cox Pipe Threader.

Westinghouse Machine-Tool Motors

are adapted for both constant and adjustable speed service. Their efficiency and durability, their reliability under the most severe conditions, their great overload capacity and low operating temperature are some of the qualities accountable for their steadily increasing use. A stock in standard capacities is always available for immediate shipment.—See Circular 1068.

Westinghouse Electric & Mfg. Co.
Sales Offices in all large Cities. **Pittsburgh, Pa.**

Are you a manufacturer who uses small power on individual machines?

Do you need a motor to go out with your finished product? Economy is what you want.

Robbins & Myers "STANDARD" Motors

(Direct Current—All Purposes $\frac{1}{20}$ to 15 H.P.)

are far superior to any other small motor on the market.

Our Engineering Department will give you free advice. It has solved many problems similar to yours. It can solve yours. We make a specialty of small direct current motors. Have given *all* our attention to them.

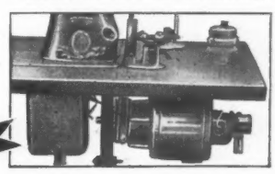
We have already designed a number of different types for special purposes—sewing machines, ice cream freezers, coffee grinders, adding machines, piano players, air compressors, pumps, etc.—which we now carry in stock.

Write us your needs. If we haven't the right motor in stock we will make it for you. Write for Bulletin No. 67, showing motors we have on hand for immediate shipment. *A motor for every machine.*

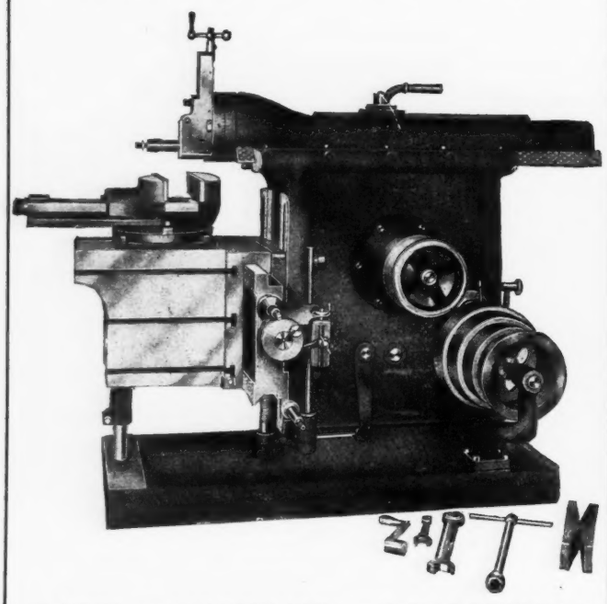
THE ROBBINS & MYERS COMPANY
Main Office and Factory, 1327-1427 Lagonda Ave., Springfield, O.

BRANCHES IN
NEW YORK, 145 Chambers St.
PHILADELPHIA, 1109 Arch St.
CHICAGO, 48 W. Jackson Boulevard.
BOSTON, 176 Federal St.
CLEVELAND, 337 Frankfort Ave., N. W.
NEW ORLEANS, 312 Carondelet St.
ST. LOUIS, Locust and 11th Sts.
KANSAS CITY, 120 W. 13th St.

Motor as on each machine.



"MILWAUKEE" CRANK SHAPERS



RAPID -- ACCURATE -- CONVENIENT
STRONG -- RIGID -- ECONOMICAL

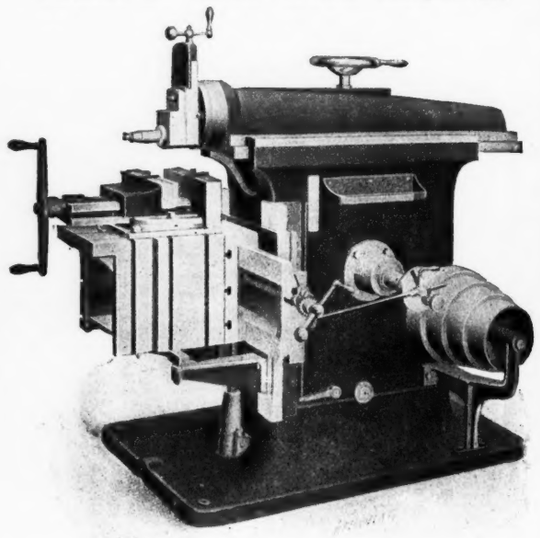
Is there any other Shaper requirement?
16-inch and 24-inch Sizes. *Ask for Circular.*

LUTTER & GIES, Milwaukee, Wis.

AGENTS E. L. Essley Machinery Co., Chicago. O. L. Packard Machinery Co., Milwaukee. Vandyck Churchill Co., New York City. Charles A. Strelinger, Detroit. Mich.

Kelly 26-inch Shaper

Back Geared or Plain Just as You Prefer or Your Work Requires.

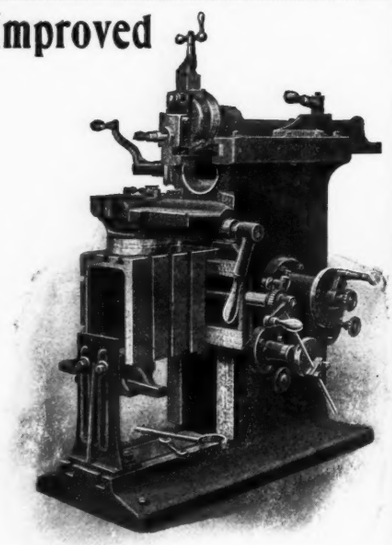


Adapted for severe service. Strong and durable. Eight cutting speeds without stopping the machine. Equal rigidity on long or short stroke. Table support a part of the machine.
Write for Crank Shaper Catalogue.

15, 17 and 20" stroke Plain.
16, 20, 24 and 26" stroke Back Geared.

THE R. A. KELLY CO., Xenia, Ohio

Juengst Improved Crank Shaper



Three Sizes 16" 21" and 26" Stroke

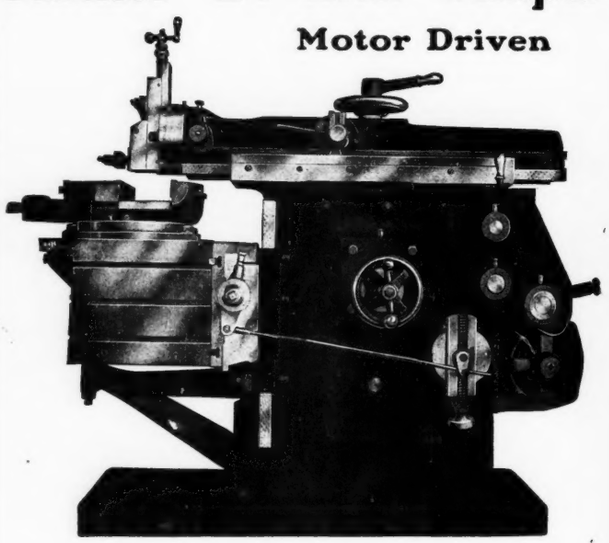
A strong, rigid and convenient machine that will handle your shaper work with a saving of at least 15% in time. All adjustments can be quickly and easily made. Stroke changed without stopping the machine. Quick return through our well known link motion. Square bearings; simple feed regulation; patent knee or table support.

Ask for latest Bulletin.

GEO. JUENGST & SONS, Croton Falls, New York

Flather 24-inch Shaper

Motor Driven

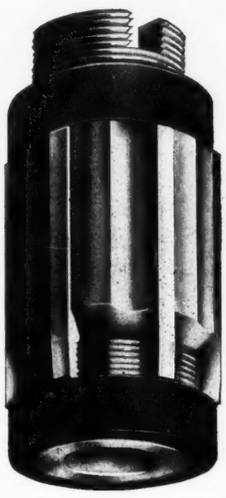


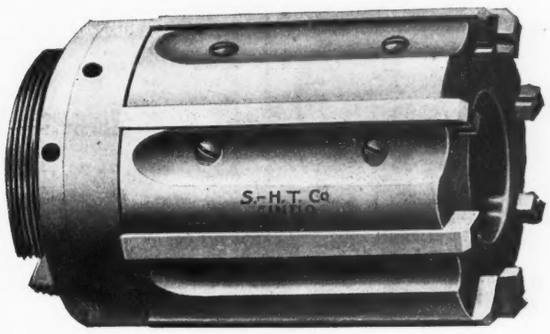
The special adaptability of this machine for motor drive is a great advantage. The ten-speed gear box covers speed variations for a wide range of work, and an ordinary constant speed motor furnishes the motive power. None of the drawbacks of the variable speed motor and only about one-third the cost. Shaper stopped and started by means of a clutch without stopping the motor.

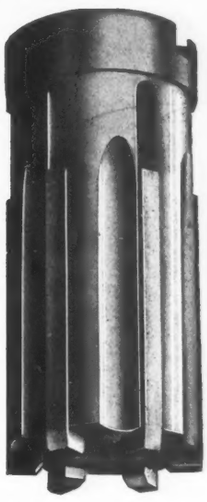
Ask for circulars.

The Mark Flather Planer Co.
NASHUA, N. H.

UNIVERSAL ADJUSTABLE TOOLS







The universal adjustable cutter boring heads and reamers make an ideal combination for standardizing holes economically. The boring heads are furnished with high speed steel cutters. They are quickly and accurately adjusted, permitting a close maintenance to size. The large range of adjustment allows one tool to be used for a number of sizes either standard or fractional. The reamers are furnished with either carbon or high speed steel blades as ordered.

"Ask the man in the shop." Catalogue upon request.

The Schellenbach-Hunt Tool Co., Cincinnati, Ohio

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, England. Markt & Co., 193 West St., New York, Germany and Italy. New York Export & Import Co., 133-137 Front St., New York, China, Japan and Australia. Williams & Wilson, Montreal, Canada. J. S. Cock, Christiania, Norway.

The "Norka" Two-Grooved High Speed Twist Drill

THE DRILL WITHOUT A TANG

This is the latest thing in the High Speed Twist Drill line and the Drill that will cut down your cost of drilling.

It has great strength because it is twisted while hot, therefore, the grain of the steel is not disturbed.

There are no tang troubles because a piece of the stock is left untwisted, forming the shank, and the jaws of the chuck fit perfectly into the grooves of the shank, not only holding the drill but also centering it.

TRADE W B MARK

It will pay you to write for our Catalogue No. 72. which shows our complete line of High Speed Tools.

TRADE W&B MARK

The Whitman & Barnes Mfg. Company

Factories: Chicago, Ill. Akron, O. St. Catharines, Ont.

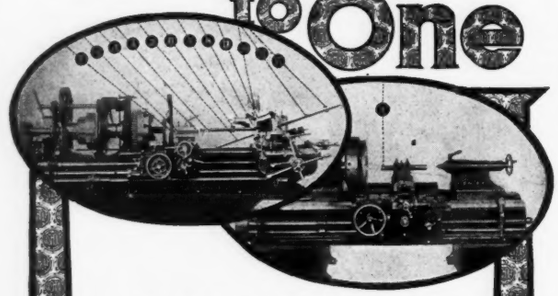
GENERAL SALES OFFICE: CHICAGO, ILL.

New York Office: 64 Reade St.

European Representative: Theodore Butler, Ltd., 149 Queen Victoria St., London, Eng.

Export Representative: A. J. Barnes, 90 West Street, New York, U. S. A.

A Dozen to One



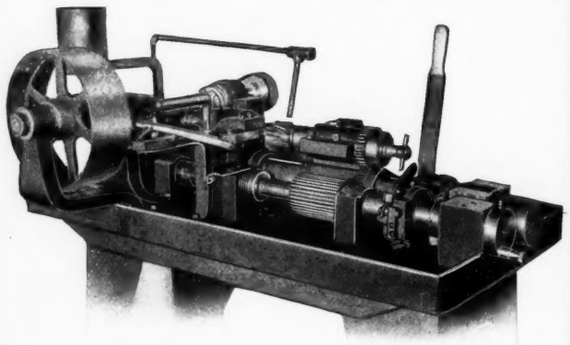
THE GISHOLT

A veritable Gatling on bored, turned and faced work. The engine lathe is a flintlock musket in comparison.

We also make
Vertical Boring Mills, 30" up to 120"

GISHOLT MACHINE COMPANY
Works: MADISON, WIS., and WARREN, PA.
General Offices:
1316 Washington Ave., - Madison, Wis., U. S. A.
Chicago Show Room, 101 Washington Boulevard.

Tap Thread Milling Machine



We are **SELLING** this machine to manufacturers having a wide range of requirements and are already receiving **DUPLICATE** orders.

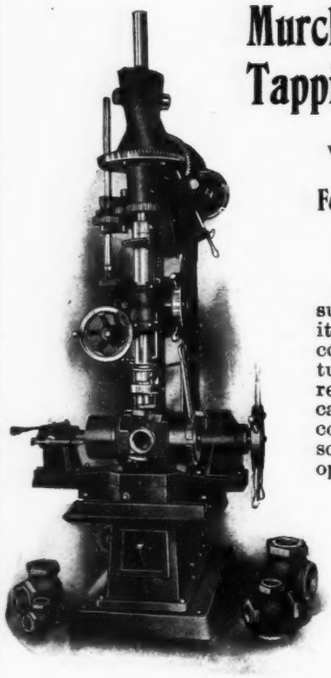
This we believe speaks for itself in regard to the efficiency of our **MACHINES.**

This machine has been thoroughly tested and we will send a sample of its product, prepaid, to responsible parties in any part of the world.

OTHER TAP MACHINERY IN PREPARATION.

BICKFORD & WASHBURN, Inc.
GREENFIELD, MASS., U. S. A.

Murchey Improved Tapping Machine



With Revolving Valve Chuck

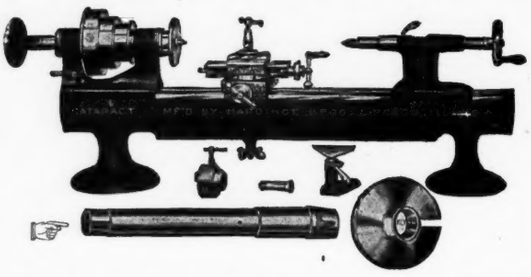
For Valves, Pipe Fittings and Special Work

A tool for results—results in quantity, in quality and in economy of cost. The patented features of this machine result in increasing its capacity, as well as its convenience of operation, so that with less effort an operator turns out more and better work. Used with our collapsible taps, which are withdrawn without stopping or reversing the machine, it saves fully fifty per cent. in the labor of tapping.

Better see what this work costs you now, and then what it would cost you with this machine. We can give you some interesting comparisons from other shops.

Murchey Machine and Tool Co.
4th and Porter Streets, DETROIT, MICH.

Cataract Bench Lathes



Isn't this Patent Spindle Nose alone worth 25% of the cost? Our lathes possess distinct meritorious patented features worth investigating. They have the largest spindle capacity for your money. Send for Catalog.

BEYER WATCHMAN'S PORTABLE CLOCKS

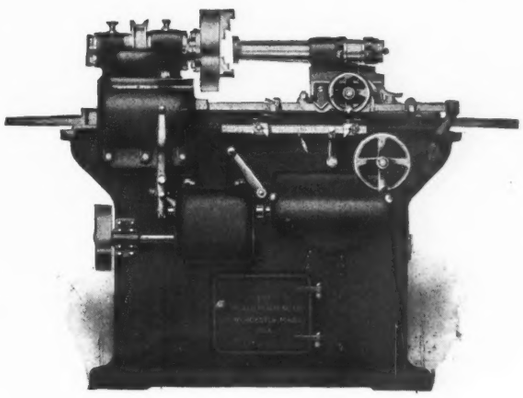
Have No Superior

Are approved by all Underwriters Associations. Every clock produces a different Record. Send for Special Catalog

Manufactured by **HARDINGE BROTHERS**
1034 to 1040 Lincoln Avenue, CHICAGO, ILL.

The Money You Spend For Accuracy is Money Well Spent

and there's really only one really accurate way of finishing perfectly round, straight holes at a reasonable price and with perfect duplication.



The Heald Internal Grinder

will grind even the thinnest walls, handle the hardest, as well as the softest metals, and cut within a limit of one-quarter thousandth, or better day after day.

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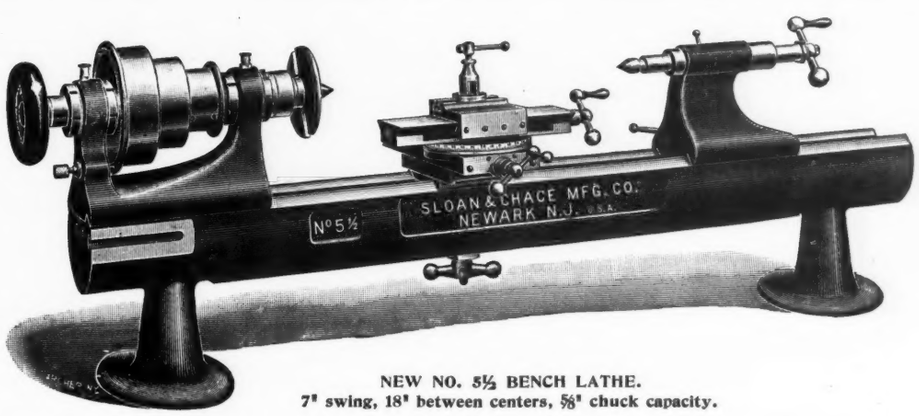
The Heald Machine Company

20 New Bond Street, **Worcester, Mass.**



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7" swing, 18" between centers, ⅝" chuck capacity.

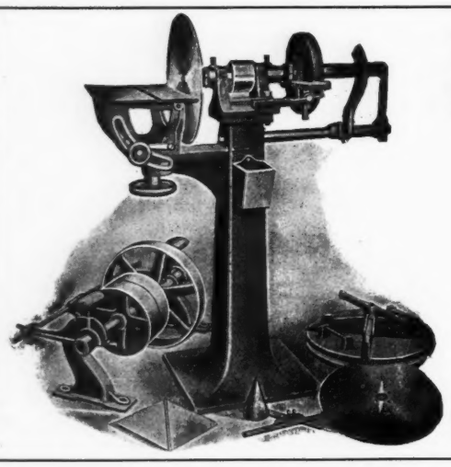
Make Profits and Friends

by using the Sloan & Chace No. 5½. It will last forever, and can be kept accurate - provisions for taking up wear. Perfect alignment and interchangeability. Special attachments for grinding, milling, boring and thread-cutting.

We also build a Bench Miller, Automatic Gear Cutters, Punches and Dies for sheet metal work, Jigs, Fixtures, Gauges, Special Machinery, etc.

SLOAN & CHACE MFG. COMPANY, Ltd.

Manufacturers of Precision Machinery. NEWARK, N. J., U. S. A.



The Adaptability of the "Rowbottom" Sanding Machine and Tool Grinder

for pattern shop work is one of its great advantages. The combination of disk and sanding roll particularly fits it for this class of work, the disk on one end of the spindle taking care of flat and angular surfaces, while the sanding roll on the other end can be utilized for internal work and irregular and curved pieces.

Time saving is another consideration.

Ask us about it.

THE ROWBOTTOM MACHINE CO., Waterbury, Conn.

A Crescent Disk Grinder

in your pattern shop will do a lot of work that you are now doing on your wood trimmer. It will grind surfaces true and smooth, round corners, and by tilting the table, will grind bevels. For a machine of its capacity the price is extremely low.

Look for the description on page 49 of 1908 CRESCENT catalog. If you do not have a catalog on file, send for it and find out about our line of Band Saws, Saw Tables, Jointers, Shapers, Borers, Swing Saws, Disk Grinders, Planers, Planer and Matchers, Band Saw Blades.

The Crescent Machine Co.
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EMERY AND CORUNDUM WHEEL

It pays to use a good grinding wheel—

That's why so many of our best manufacturers specify

Sterling Grinding Wheels

Wide range of sizes, shapes and grades.

The Sterling Emery Wheel Mfg. Co.
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BRANCHES: New York House, 45 Vesey St. Chicago House, 60 West Washington St. San Francisco House, 461 Market St.

Grinding Machines

Different Styles and Sizes for Floor and Bench.

EMERY WHEEL DRESSERS

No. 1 For Regular Shop Use.

No. 2 For Large Wheels.

These Dressers in connection with our Cutters make a most powerful and efficient tool, espscially our No. 2 which is made proportionately larger and stronger for large wheels.

CUTTERS

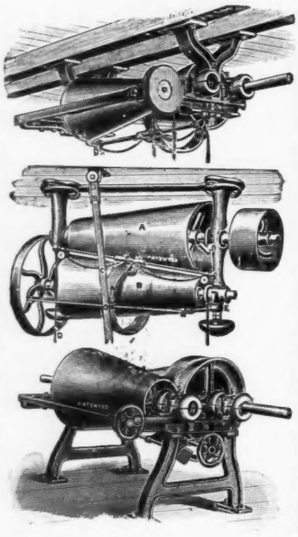
We make the regular "Huntington" (pattern) Paragon Cutter and Roughing Cutters for Dresser No. 1, and the "Huntington" (pattern) and Roughing Cutters for Dresser No. 2.

Let us send you descriptive circular and prices.

GEO. H. CALDER, Lancaster, Pa., U. S. A.

Evans Friction Cone Pulleys

VARIABLE SPEED COUNTERSHAFTS



Will drive your machine at any desired speed from 1 to 6. Over ten thousand sets in operation in this country and Europe. Send for catalog.

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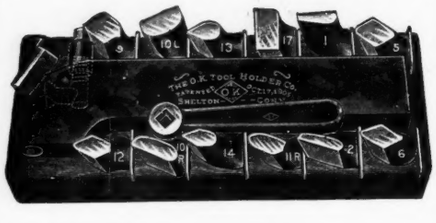

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The Veeder Speed Indicator

A new device for counting the rotations of machinery. Can be used in places where it would be impossible to operate any other counter; no stop watch needed, and operation rendered extremely easy by the provision of ball thrust bearings.

Particularly adapted for shafting, operates equally well in either direction. Can be depended on at high or low speeds, and as it is not affected by magnetism, will be found of especial advantage in connection with generators and motors. Ask for circular.

PRICE $3.00.

THE VEEDER MFG. CO., 39 Sargeant St., Hartford, Conn.

THE SCHWERDTLE STAMP CO.,
STENCILS-BURNING BRANDS
STEEL STAMPS & DIES
SEALS-MACH. PLATES-CHECKS
BRIDGEPORT, CONN.

"MONARCH" GRINDING WHEELS

Your grinding cannot be too carefully considered nor the selection of your *grinding wheel* made too important. The results of one depend on the correct choice of the other. Let us suggest the **Monarch Wheel** best suited to *your* needs.

Monarch Wheels are cool cutting and even tempered. Their composition is a matter of science. They combine strength and porosity. They are graded for every grinding purpose, are made in all sizes and face shapes, and can be used wet or dry with equal efficiency

Full data furnished on request

Monarch Emery & Corundum Wheel Company CAMDEN, N. J., U. S. A.

For All Kinds Of Accurate Surfacing

For fitting keys, sharpening punches, dies and all grinding to Micrometer Feed, the

TRADE MARK

LaSalle Plain and Surface Grinder

permits the finest adjustments to be easily and quickly made. Plenty of well distributed weight makes the machine solid, durable and very accurate.

A dividend paying investment in any shop. *Catalog?*

LA SALLE MACHINE AND TOOL COMPANY
LA SALLE, ILL., U. S. A.

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14-inch to 32-inch Stroke.

Crank and Triple Geared.

John Steptoe Shaper Company, Cincinnati, Ohio.

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The general promotion of A. L. A. M. Standard of thread for bolts, screws, etc., opens our way for emphasis:

In Drop-forged Wrenches of most saleable types, we carry regularly in stock U. S., A. L. A. M. and Whitworth Standards; metric measure to order. Ready for foreign or domestic equipment of your machinery product.

We are ready too, with a selected line of ultra-serviceable Wrenches put up in sets—packed in canvas rolls. A great and worthy seller is our

"Big Six"

with capacity of 15 milled openings in six Wrenches—7 most important Bolt sizes, ¼ to ¾, and 8 most important Cap Screw sizes, ¼ to 1"—surely a "big six."

Set #1, 5 Light Wrenches, Mfrs. Standard - - $\frac{3}{32}$ to $\frac{15}{16}$ openings
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Set #4, 6 Heavy Wrenches, U. S. Standard (Big Six) $\frac{7}{16}$ to $1\frac{1}{4}$ "
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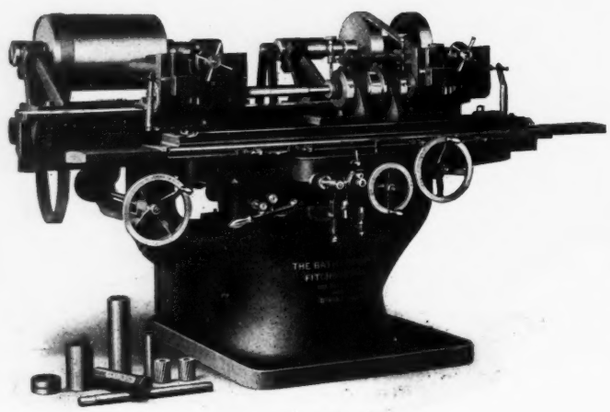
Can furnish sets and millings as required, to order.

See your dealer for discount and details.

J. H. WILLIAMS & CO.
SUPERIOR DROP-FORGINGS
BROOKLYN, N. Y. CITY

The Bath Double-Headed Internal Grinder

is not a cylindrical grinder with an internal attachment—it is designed first, last and all the time for Internal Grinding.



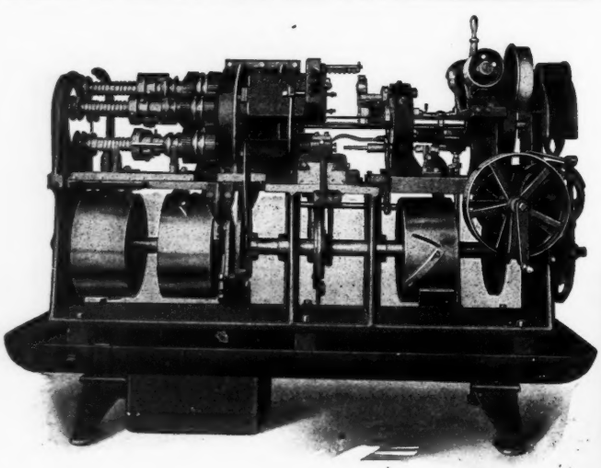
Ask for further good points of a particularly good machine.

It is the most rigid machine of its class, is adapted for a great variety of internal grinding and has the advantage of grinding two pieces of work, or two diameters in the same piece at one time. The two spindle heads are independent of each other and each is provided with independent automatic feed for feeding the wheel to the work. By a special form of construction all vibration is absorbed, permitting the use of a wheel only 1-16″ smaller than the hole being ground, thereby adding a large percentage to the efficiency of the wheel. Diamond tools may be so set that they true the wheel every time it passes in or out of the hole, and keep the wheel continually up to its original sharpness.

The Bath Grinder Company, Fitchburg, Mass., U.S.A.

FOREIGN AGENTS—Japan, Alfred Herbert, 224 Yamashito-cha, Yokohama. Northern and Eastern Germany and Austria-Hungary, Heinrich Dreyer, Kaiser Wilhelm str. 1, Berlin. Western and Southern Germany, Switzerland, Holland, Belgium, France, Spain and Italy, Alfred H. Schutte, Neumarkt 18, Cologne.

10 Operations Simultaneously Performed—
One set of tools working on different bars of stock



A time saving, cost saving, labor saving machine for screw work of every character—brass, iron, steel. Automatic in every move. Drive is by one straight belt from the countershaft. Threading mechanism positively driven from the spindles.

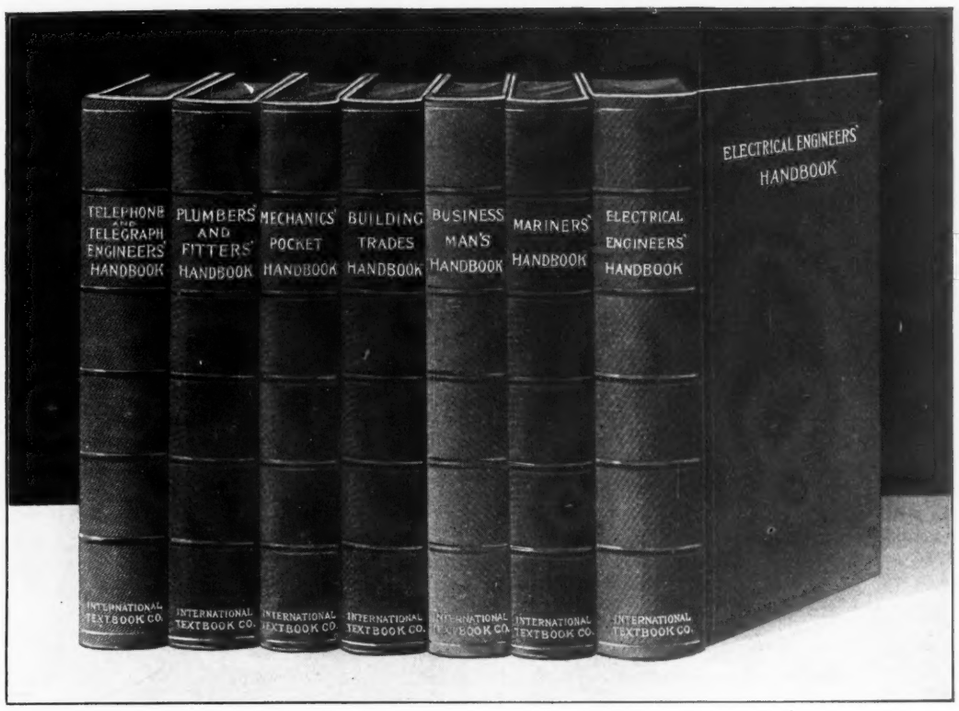
Samples of Work.

The Universal Multiple Spindle Automatic Screw Machine

Let us estimate on your work—the figures will surprise you.

The Universal Machine Screw Co., Hartford, Conn.

DOMESTIC AGENTS: Prentiss Tool & Supply Co., New York, Boston, Buffalo. Motch & Merryweather Machinery Co., Cleveland, Detroit, Cincinnati. Brown & Zortman Machinery Co., Pittsburg, Pa. Marshall & Huschart Machinery Co., Chicago, Ill.



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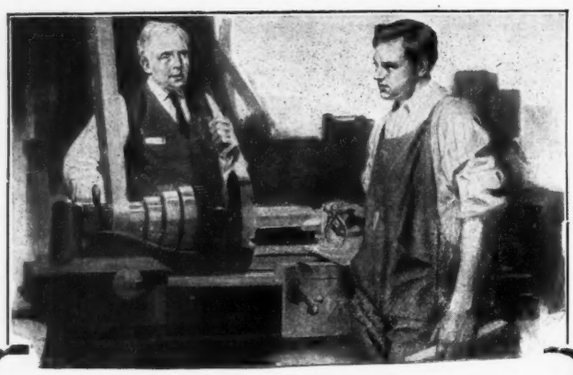

PROMOTED!

Don't you worry about the boss not having his eye on you and noticing the improvement in your work. Remember that he is human—he is on the look-out for good men—his own success, and the firm's, depends on his ability to select the right man.

If you are a little better than the other man—if you know more about your work than he does, do you suppose the boss would pass you by and boost the other fellow?

You wish you had a better job. You wish you knew more, then you could do more and earn more. Tell us your name, address and occupation and we will tell you how your wishes can be realized. Our advice, based upon the experiences of successful students and graduates, will cost you nothing. It may start you right and change your whole future. Ask for this information today -IT'S FREE.

We Help Men Help Themselves.

American School of Correspondence, Chicago, U. S. A.

Mention Machinery, June '09.

PORTABLE TOOL CASES

"For the man who cares"

STYLE 31 - the best tool case on the market; can be easily carried, will last indefinitely, is well proportioned and finished, with all space utilized, and is just the thing to keep fine tools properly arranged and in good condition. Drawers are lined with felt and an especial feature is the patent self-hinging lid, which has felt lined tray and will slide in under the bottom drawer out of the way when desired. Outside measurements of case, 16" long, 11¼" high and 8½" deep. Inside measurements of drawers, 6⅝" and 14¼" long, 6¼" deep and range from ¾" to 3" in height. Spring lock, leather handle, brass or nickel trimmings.

Every machinist and toolmaker needs one of these cases--shipped direct from factory for $12.00--and money refunded if not satisfactory.

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DAYTON, OHIO

Manufacturers of Mechanics High Grade Tool Cases
815-821 Germantown St., DAYTON, OHIO, U.S.A.

Uncle Sam and the "Flat"

The United States Government is using "USE-EM-UP" Drill Sockets in eighteen places, including the Canal Zone. Guess they must be all right.

Here 'tis

The "USE-EM-UP" Drill Socket

Just grind a flat on the drill shank and your drill drive troubles are over.

Send for descriptive price list.

American Specialty Company
CHICAGO

One One-Thousandth of an Inch

Or "Just About a Hair"

Of these two expressions one is a definite amount and is easily measured with a Micrometer. The other is very indefinite and leads to costly mistakes.

SLOCOMB MICROMETERS

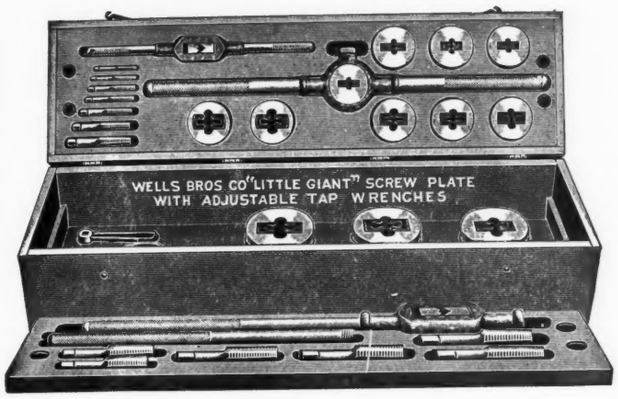
are proof against variation from wear. An extra long bearing between the nut and the screw prevents wearing out of pitch, and maintains the original reliability and exactness after years of hardest service.

89 styles and 21 sizes. Ask for Catalogue No. 12.

J. T. SLOCOMB, Providence, R. I.

AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. Ludw. Loewe & Co., Berlin, for Continental Europe. Thos. McPherson & Son, Melbourne, Australia.

"Little Giant" Tools are Best Known where the Best Work is Done

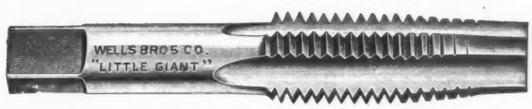


Because the high grade workman uses the tools that serve him best and wear the longest.

The quality of "Little Giant" Taps, Dies and Screw Plates was established years ago and is maintained without variation.

They are uniform, accurate, durable and adapted for their work.

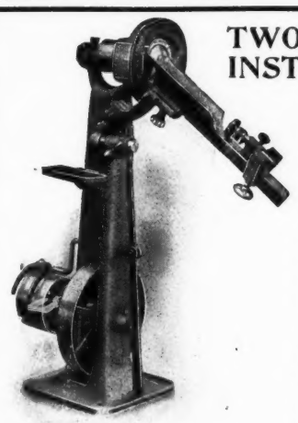
Ask for Small Tool Catalogue.



Wells Bros. Company

Greenfield, Mass., U. S. A.

NEW YORK STORE 126 Chambers St. | CHICAGO STORE 54 W. Washington St. | LONDON STORE 149 Queen Victoria St.



TWO ADJUSTMENTS INSTEAD OF NINE

or more. That's why a

NEW YANKEE Drill Grinder

will finish grinding a drill while any other drill grinder is getting ready to start grinding. That is why a NEW YANKEE is used where other drill grinders stand idle. Saves drills, insures accuracy, saves time and costs only a trifle.

Free catalog describes over 50 different styles and sizes.

Wilmarth & Morman Co.

580 Canal St., Grand Rapids, Mich.

Agents for Great Britain: C. W. Burton, Griffiths & Co., London. Buck & Hickman, Ltd., London.

REAMERS

The KELLY Adjustable

MADE IN

ONE STYLE ONLY

Finish, Ream or Rough-bore ANYTHING from a

ONE-INCH to a SIXTY-INCH CYLINDER

Type B for the Turret. Type C for Cylinders.

THE KELLY TOOL CO., Cleveland, U.S.A.

Nicholson's Expanding Mandrels

Our Catalogue tells more about them.

save time and money. While a man is hunting through a lot of solid mandrels to get one of the right size for the job in hand, the work could be half done with a Nicholson Expanding Mandrel. Isn't this worth looking into?

Made in sets of nine; fit any sized hole from 1 to 7". Strong, durable tools; compact and convenient; all parts interchangeable. Always ready, always right.

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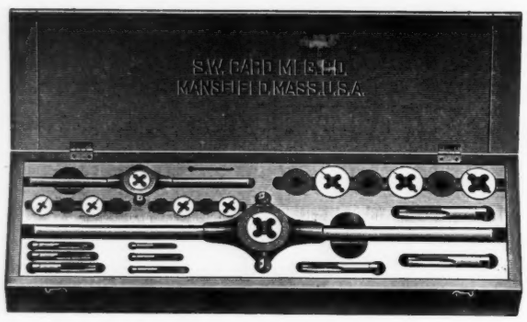
WILKES-BARRE, PA., U. S. A.

FOREIGN HOUSES—C. W. Burton, Griffiths & Co, London Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Stockholm, St. Petersburg.

Card "Quality" Screw Cutting Tools

Screw Plates

All standard styles and sizes for machinists, blacksmiths, gunmakers, watchmakers, for bicycle and automobile manufacturers—strong, adaptable and complete.

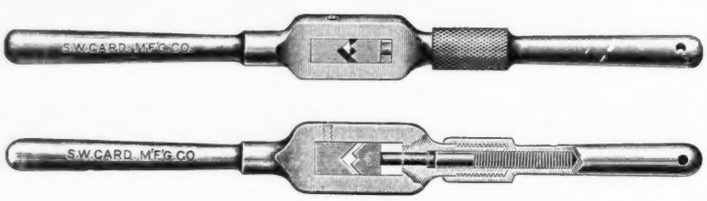


Card "Improved" Screw Plates

are furnished with patent adjustable dies and steel guides. Dies are adjusted by means of a tapering screw, allowing sufficient adjustment to obtain either a tight or a loose fit, and will always grip the screw whether it is moved in or out, thus keeping the teeth of the dies in perfect alignment.

A Patent Tap or Reamer Wrench

is furnished with regular screw plate sets; drop forged from bar steel, hardened steel jaws, light, strong, durable—an up-to-date tool in every particular.



Ask for latest catalogue of Taps, Dies, Screw Plates, etc.

S. W. Card Manufacturing Company

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This is a Coes Genuine Wrench

Looks good, doesn't it? And it *is* good — the best wrench for general service on the market.

30 per cent. stronger, size for size, than any other wrench; wears longer, is more convenient and has no loose parts to get out of order.

"Coes" Wrenches are made in 5 styles and 50 sizes. If there is anything you need in the wrench line — a "Coes" will meet requirements.

Ask your dealer

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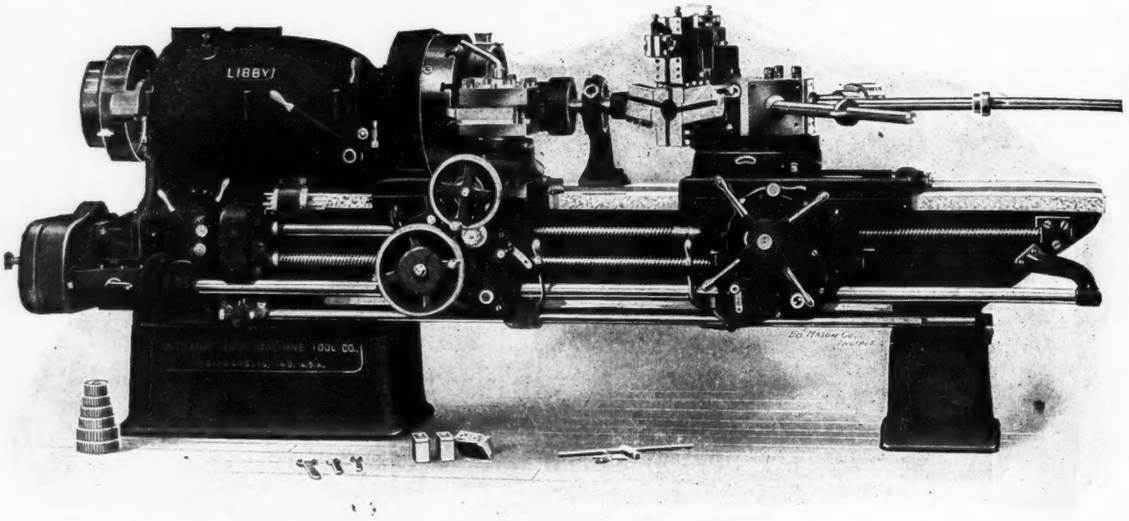
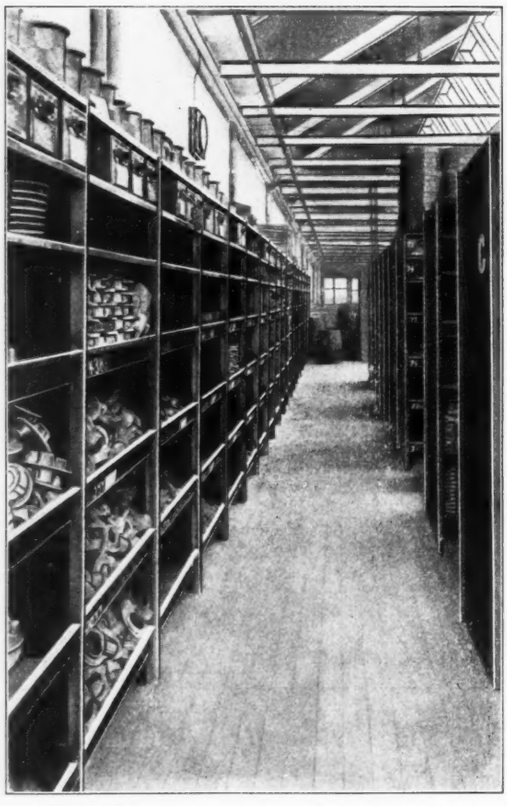
"The Machine Tool Hog"



A regular "get-together-club" of workers, you might call the tools on the **Libby Full Swing Side Carriage Turret Lathe**—grouped in gangs of from two to six tools, all working at once, they are hard to beat when it comes to facing off surfaces, forming pieces, etc. The time saving and economy that results from "Libby" methods are matters of importance to every manufacturer, and the machine itself with its enormous strength, great rigidity, unusual driving power and wide adaptability, is an example of mechanical efficiency we would be glad to describe in detail.

Catalogue—or shall we send a representative?

INTERNATIONAL MACHINE TOOL CO., Indianapolis, Ind., U. S. A.



Lyon Racks with Bin Attachment showing variety of material stored.

LYON STEEL RACKS

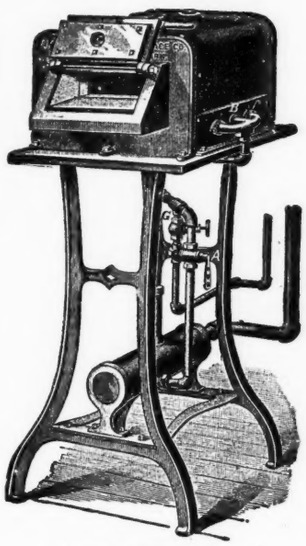
Are the ideal storage racks for the shop or factory.

Practical, adaptable and above everything else, strong. The keynote of design and construction is strength—Lyon Racks will carry the guaranteed load per foot without the employment of an ounce of unnecessary material. No bracing of shelves is required No danger from unequal loads. They are built on the unit system, with every part and attachment standardized; you can add to your racks as occasion demands, adjust them to any special space, or arrange them for special uses.

Compact, well finished, easily installed.
The book sent on request.

Lyon Metallic Mfg. Company
AURORA, ILLINOIS
Steel Racks, Lockers and Factory Equipment

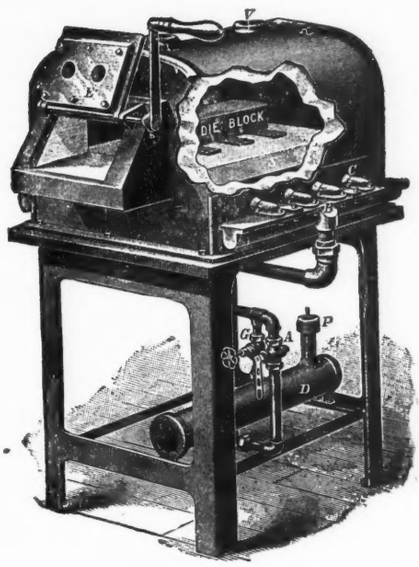
SCIENTIFIC ACCURACY



Oven Furnace No. 16
Much used for light work, cutters, dies, tools, etc.

The Heating and Tempering of fine tools, small machine parts, high speed steels of every brand, has been brought close to perfection with

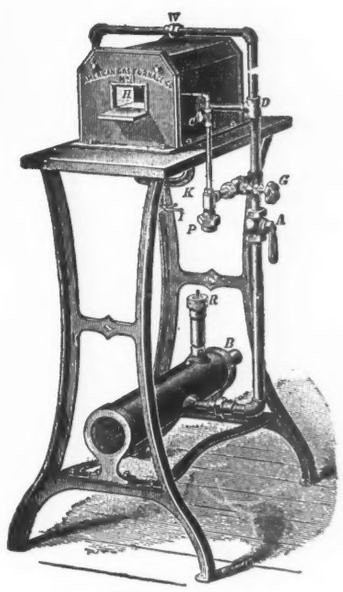
American Gas Blast Furnaces



Oven Furnace No. 1
A size adapted for general hardening and annealing.

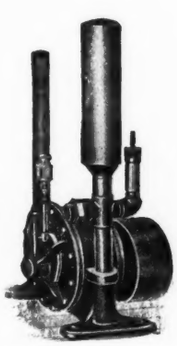
Scientific accuracy is the watchword in design and operation. They are built especially for their purpose; temperature is under absolute control at all times; danger of tools cracking or warping, of scale or oxidization is entirely absent. They can be relied on for exact results, are economical in gas consumption, compact, cleanly and made in a range of styles and sizes to cover every need.

Blast under pressure of 1 lb. to square inch indispensable.



Tool Room Forge No. 1
For general tool room work.

Complete Catalogue of Gas Furnaces and Heating Machines on request.



Positive Pressure Blower

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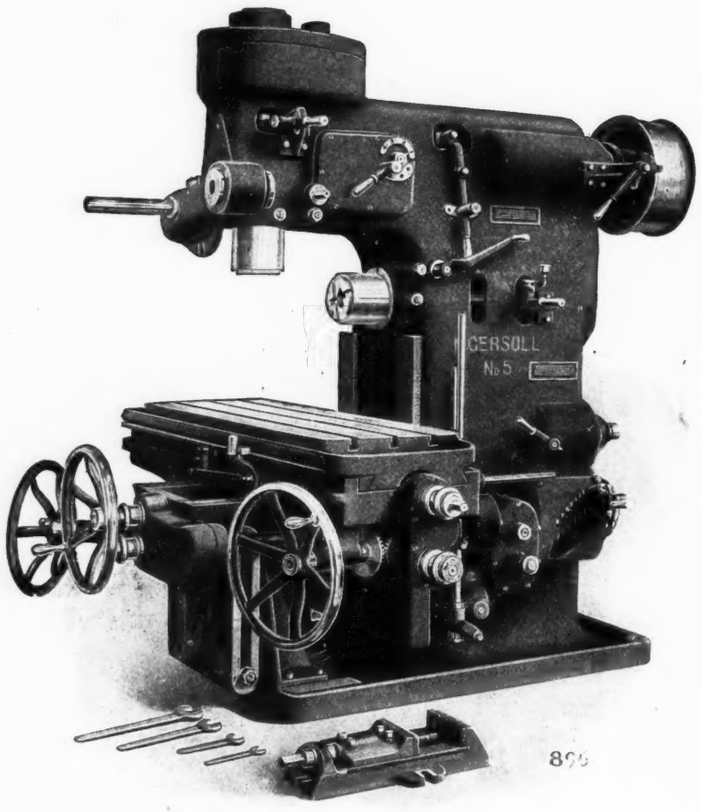
Unites all the advantages and conveniences of either type miller in one machine.



It is of the most improved construction, with strength and rigidity to take the heaviest cuts, either horizontal or vertical, without vibration or trouble of any kind.

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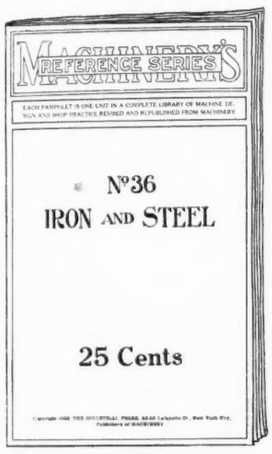
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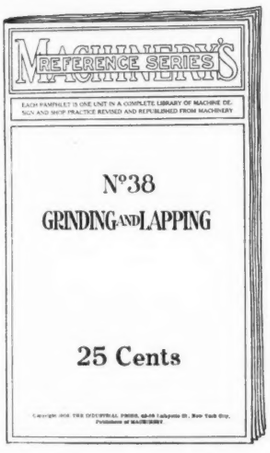
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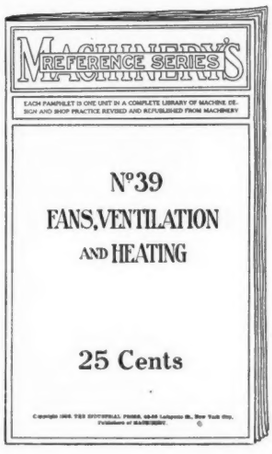
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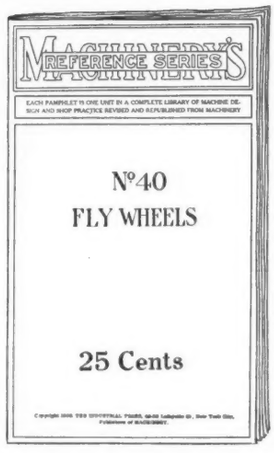
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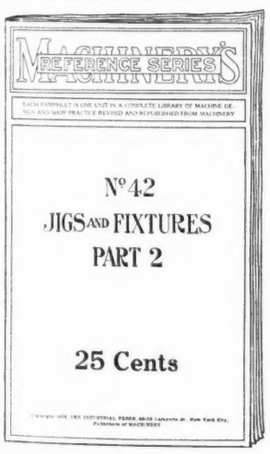
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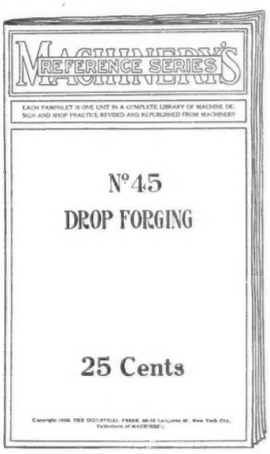
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THE UNIT SYSTEM OF SELF-EDUCATION--3

Notice of Increase in Price of MACHINERY'S Data Sheets and Shop Operation Sheets taking effect August 1, 1909.

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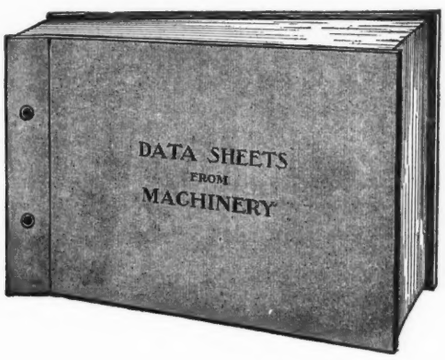

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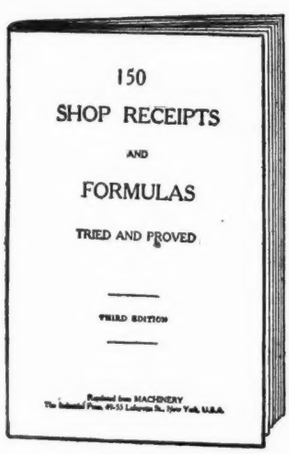

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THE UNIT SYSTEM OF SELF-EDUCATION--4

ORDERS for the Data Sheets will be accepted at the present rate, $2.50 per set filed in two binders, until August 1, 1909, *but not thereafter.* The two new offers, A and B, which follow, are good until August 1, and are open to *everybody*, whether subscribers for MACHINERY or RAILWAY MACHINERY now or not. Present subscribers by accepting, renew from expiration date.

OFFER A

Subscription for MACHINERY, Engineering Edition, 1 year -	$2.00
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USE COUPON ON LEFT AT FOOT OF PAGE

OFFER No.2—THE UNIT SYSTEM OF SELF-EDUCATION

24 Reference Series Books at 25 cents each (select your titles) - - - - -	$6.00
18 Jig Sheets—select your titles from Groups A or B—see page 132—or take 4 Reference Books instead, if you prefer - -	1.00
Complete Set Data Sheets filed in two binders, value after August 1 - - - - -	4.00
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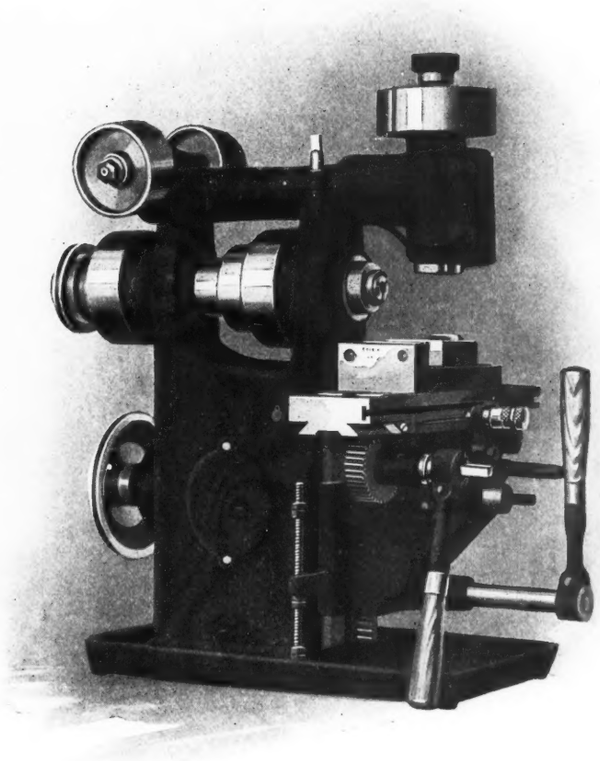

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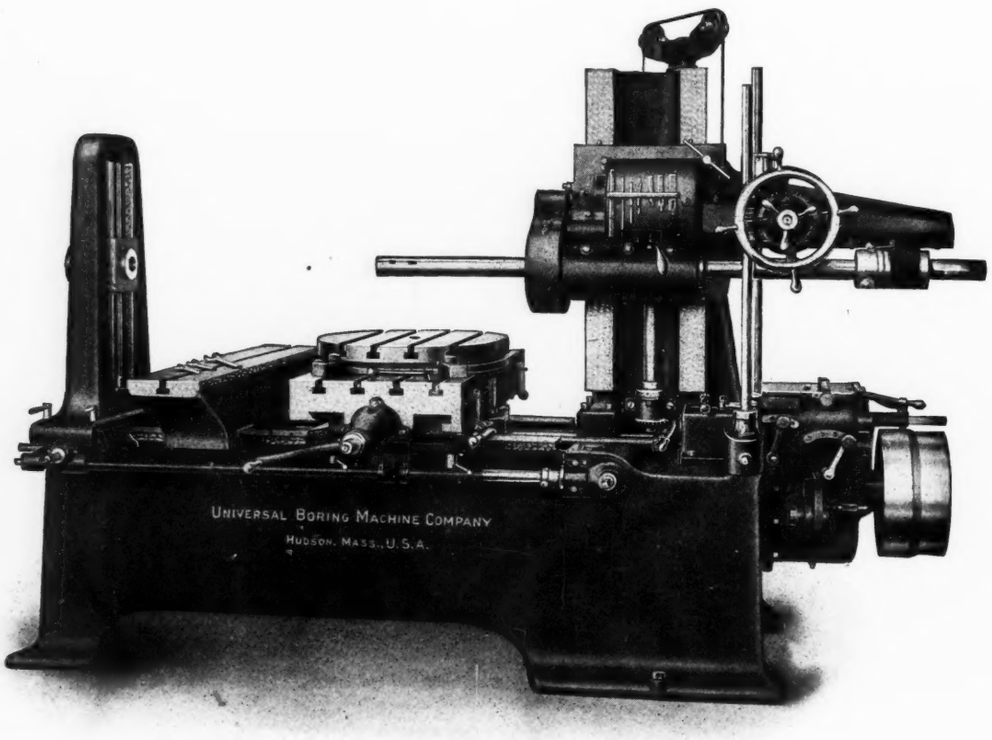

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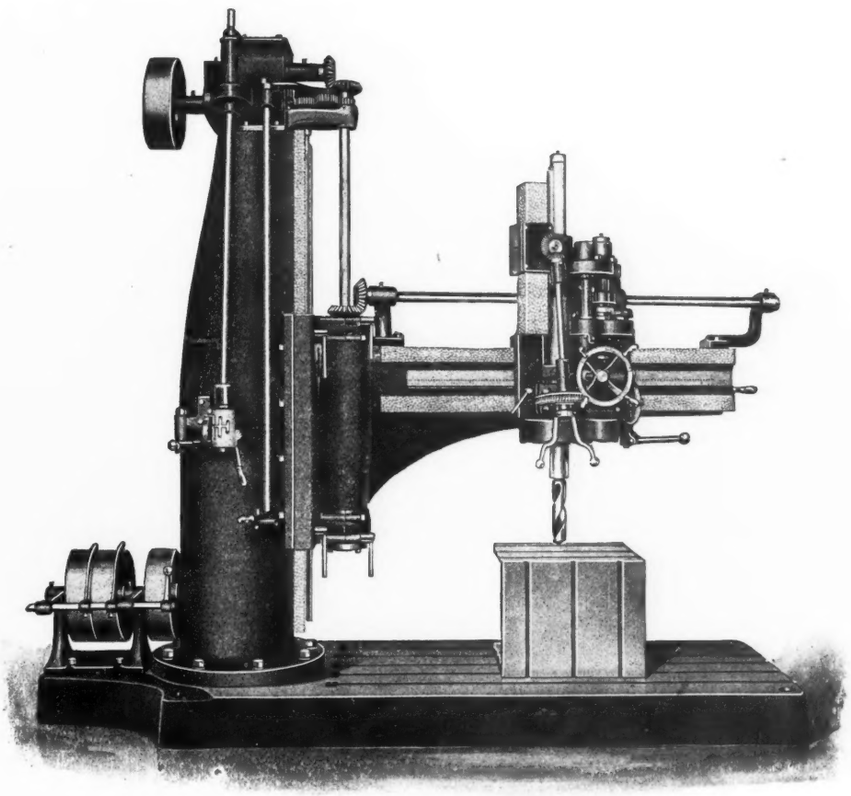

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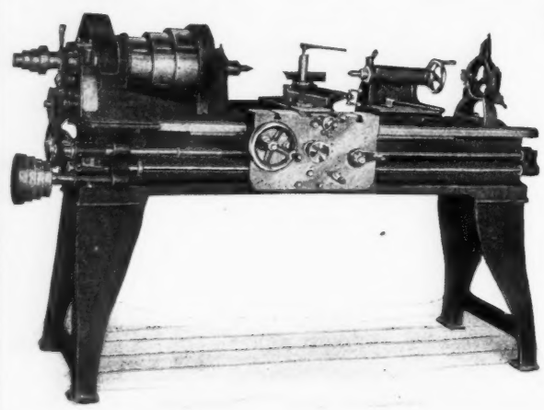

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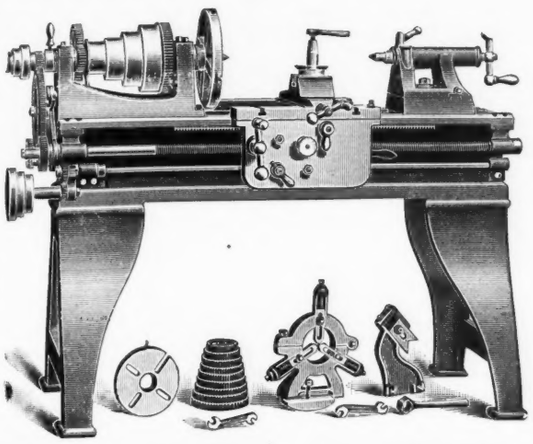

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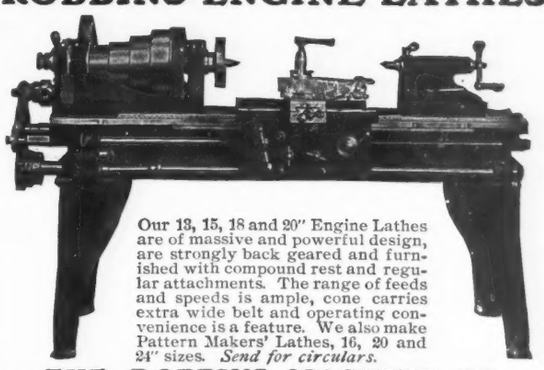
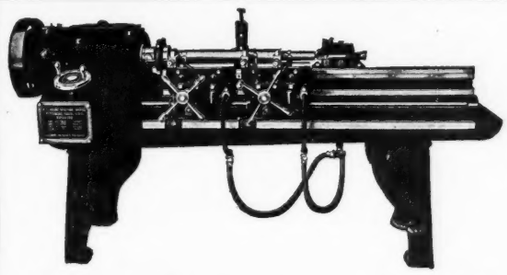
ROBBINS ENGINE LATHES



Our 13, 15, 18 and 20" Engine Lathes are of massive and powerful design, are strongly back geared and furnished with compound rest and regular attachments. The range of feeds and speeds is ample, cone carries extra wide belt and operating convenience is a feature. We also make Pattern Makers' Lathes, 16, 20 and 24" sizes. *Send for circulars.*

THE ROBBINS MACHINE CO.
149 Lagrange Street Worcester, Mass., U. S. A.



Ask for Catalogue.

The Lo-swing Lathe

a heavy duty machine for turning straight and taper shafts, cutting two to six diameters at once.

FITCHBURG MACHINE WORKS, Fitchburg, Mass.

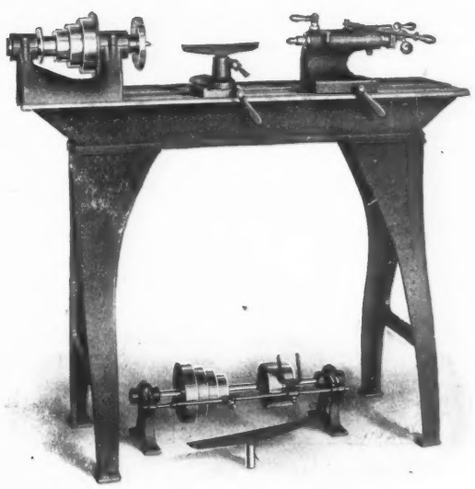
14" LATHES EXCLUSIVELY

A high grade tool at a moderate price. **Has geared rod feed, also belt feed,** and fully guaranteed throughout.

Send for circular.

Carroll-Jamieson Machine Tool Co.
BATAVIA, OHIO

"SENECA FALLS" 10-INCH SPEED LATHE



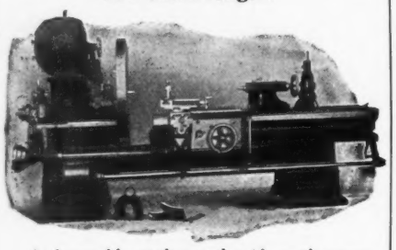
Another of the notable "Seneca Falls" tools, carefully designed, well built with strong, rigid bed thoroughly braced with cross webs. Self-oiling, dust-proof bearings, tailstock with combination screw and lever feeds, are features of this machine; locking levers are attached and always in place; countershaft has self-oiling and self-aligning bearings. Draw-in chuck and split collet furnished when desired. 10" in. and 12" sizes. Ask for catalogue B.

The Seneca Falls Mfg. Company
330 Water Street, Seneca Falls, N. Y. 144 A

Extension Gap Lathes

MOTOR DRIVEN

For turning work of large diameter and extra length.



A thoroughly modern tool, with ample power and strength to turn the full swing in the gap, while entirely free from any features that make it awkward or objectionable for ordinary work. The extension bed not only increases the swing, but also the distance between centers—an important advantage in turning long work.

If you will permit us to point out in detail the advantages of this type over the ordinary gap lathe, or double spindle lathe, you will be glad you investigated. Information is always valuable and in this case it costs nothing.

Fay & Scott, Dexter, Me.

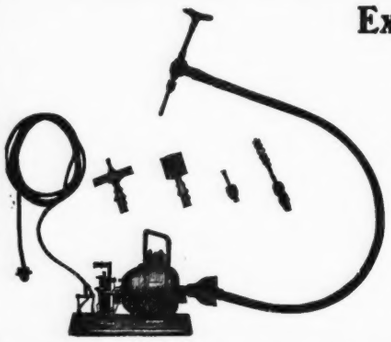
Makers of STANDARD ENGINE, TURRET AND PATTERN MAKERS' LATHES.

Twenty to Thirty Letters can be Engraved with the Gorton Engraving Machine at a Cost of One Cent.

This is a fact which should interest you and we would like an opportunity to prove that the machine will not only do better work than can be done by hand, but do it in a fraction of the time usually required. Engraving either in relief or sunken, on metal plates, seals, dies, patterns, etc.

Send samples of your requirements, we will then duplicate the same, stating the time required, quoting price with photo on suitable equipment.

GEORGE GORTON MACHINE CO., Racine, Wisconsin



Examine the Time Cards

in your shop for a day—figure out how much of the time gone for **hand work** or in **mounting** work could have been saved, if the

STOW FLEXIBLE SHAFT and READY ELECTRIC MOTOR

had been at hand. **Drilling, reaming, tapping, grinding, polishing,** etc., accomplished quickly and with precision.

Steam or Pneumatic motors—also attachments for shaft driving.

It saves money—write for particulars.

STOW FLEXIBLE SHAFT CO. PHILADELPHIA PA.

Another Victory for

GANDY RED STITCHED COTTON DUCK BELTING

On Nov. 18th, 1907, we secured a judgment against Weller Manufacturing Co. for selling imitations of the Genuine Gandy.

And on Feb. 5th, 1909, the Circuit Court of the U. S., Western District of Pennsylvania, issued an injunction against C. A. Turner, Inc., from infringing upon our rights.

GANDY TRADE-MARKS are registered and will be protected, so don't be deceived. Every belt shows every ten feet **"GENUINE GANDY BELT."**

We also make Gandy Belt Dressing and issue a free booklet "Experience with Gandy."

THE GANDY BELTING CO.
BALTIMORE, MD.

Find out your Machine Speeds, then make your Figures

The man who *knows* the speed at which the tools in his shops are running can figure a good deal closer, and still be sure of a safe margin of profit, than the man who *guesses* at the rate of production.

The Cut-Meter

will help you to estimate closely. Lets you know exactly, instantly and easily the cutting speed in feet per minute of any machine tool. Costs little, lasts long.

Write for Catalogue.

WARNER INSTRUMENT CO.
56-59 Roosevelt Ave., BELOIT, WIS.

1781 Broadway, New York. 143 Federal St., Boston.

My Product Consists of

Sensitive Drills
1 to 12 Spindles.
With or without Power Feed.

Clamp Drills
2 Styles. 4 Sizes.

Blacksmith Drills
Hand and Power.

Nut Tappers
2-3-4 Spindles.

Planer Chucks
Round and Square Base.
6", 8", 10", 12", 15", 18", 24", 30" jaws.

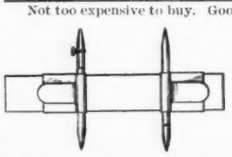
FRANCIS REED CO.
WORCESTER, MASS.

Sawyer Tool Mfg. Co.

FITCHBURG, MASS.

Machinists' Fine Tools.
Steel Rules a Specialty.

Not too expensive to buy. Good enough to use is this



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Every engineer, machinist, draftsman or home study student needs one. Ready for instant use.

Complete with pen, pencil, needle points and 12-in. Beam, postpaid for $1.00.

P. S. ANROS CO., Lock Box 81A, North Tonawanda, N. Y.

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G. W. Hoffman, Sole Prop. 235 E. Wash. St.
INDIANAPOLIS, IND.
TRADE MARK
INFALLIBLE
FOR POLISHING GOLD, SILVER, PLATED WARE, NICKEL, TIN, BRASS, COPPER, Etc.
DIRECTIONS:
Take a little of the Polish on a soft cloth, rub the Metal hard and then wipe it off with a dry cloth

Metal Polish

Highest Award
Chicago World's Fair, 1903.
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3-oz. Box for 10 cents
Sold by Agents and Dealers all over the world. Ask or **write for FREE samples**
5-lb. Pails, $1.00

GEO. W. HOFFMAN
Expert Polish Maker
Indianapolis, Indiana

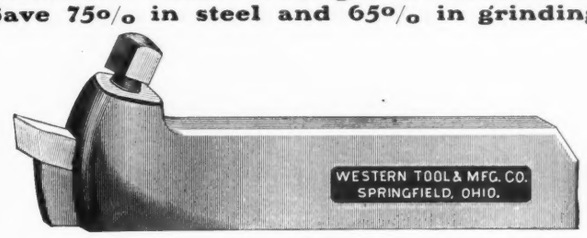
DIE CAST PARTS

BERRY & PARKER, Erie, Pa., U.S.A.

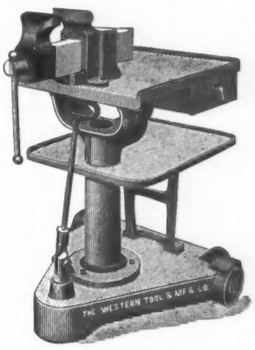
Champion Tool Holders

Big Head. Big Cutter. Patented Support under the Cutter. Strongest on the market. Save 75% in steel and 65% in grinding.

Portable Tool Stand



Write for Catalogue

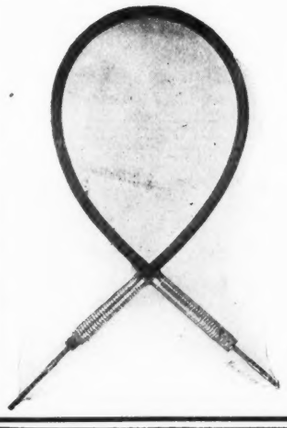


Portable Vise Stand

THE WESTERN TOOL AND MANUFACTURING COMPANY, Springfield, O.

A Shaft for the Hardest Service

The Hahn Flexible Shaft

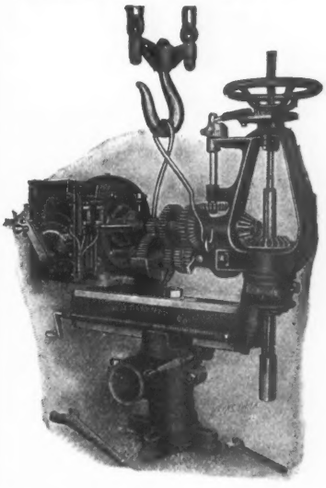


can be run in either direction with equal efficiency and is particularly well adapted for operating grinding tools, portable drills and for a wide range of similar uses. The principle of construction, consisting of multiple coiled springs of piano wire, insures the utmost strength and durability under extreme service. Made in various sizes.

Ask us for full description.

WM. HAHN, Chicago, Ill.
621-623 N. Campbell Ave.

"Dallett" Motor-Driven Portable Drills



For Drilling in Every Position; Portable, Standard and Radial Drill in one.

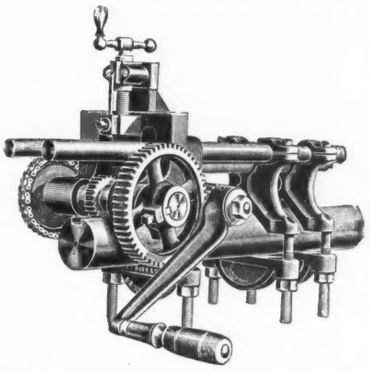
THREE SIZES:—
No. 1—Weight 225 lbs.
No. 4 Weight 720 lbs.
No. 5—Weight 1300 lbs.

Write for Bulletins.

Thos. H. Dallett Co.
23d and York Sts., PHILADELPHIA, PA.

Perfect Key-Seats in Shafting

THE BURR PORTABLE KEY-SEATER



is indispensable for the repair shop. Can be carried anywhere, slipped over heavy shafting or spindles, has capacity for key-seats up to 5 inches diameter, and will mill a key-seat 12 inches long without resetting.

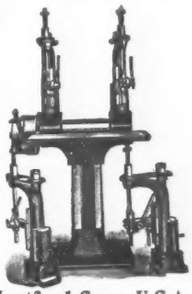
This tool can be used in almost any position and in the most cramped places. It is rapid in operation, cuts without jar or chatter and produces accurate work.

Made in two sizes—No. 1, as shown, $40.00 net.

Send for circular.

JOHN T. BURR & SONS, 34 South Sixth St., BROOKLYN, N. Y.
Selig, Sonnenthal & Co., London.

Mighty handy for jig work



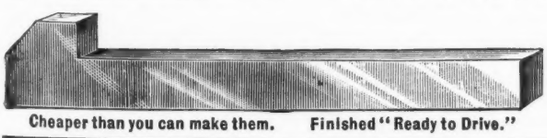
Our Manufacturers' Drill has adjustable top columns, three changes of speed for each spindle entirely independent of each other, lots of power, positive drive, quick changes of speed and plenty more good features which we can't tell about here. Get the catalog.

1 to 6 SPINDLES

The Taylor & Fenn Co., Hartford, Conn., U.S.A.

E. Sonnenthal, Jr., Berlin, Cologne, Vienna and Frankfort-on-Main, Agent for Germany and Austria. R. S. Stokvis & Zonen, Rotterdam and Brussels, Agents for Holland and Belgium.

Finished Machine Keys



Cheaper than you can make them. Finished "Ready to Drive."

Gib and Plain Head
All sizes carried in stock
Write for discounts.

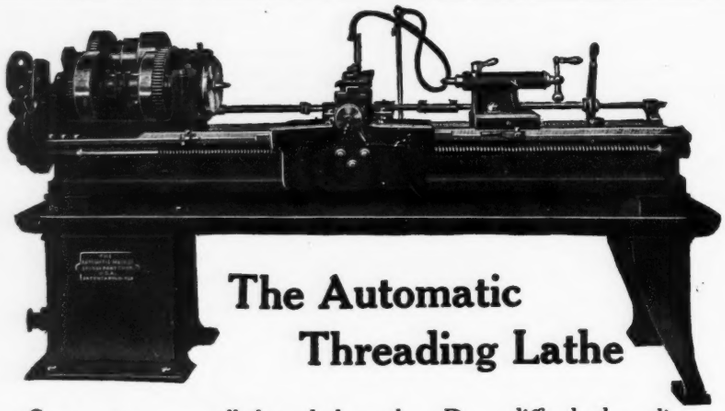
OLNEY & WARRIN
66-68 Center St., New York

THE OPEN SIDE PLANERS

Horizontal Drilling, Boring and Milling Machines

THE DETRICK & HARVEY MACHINE CO., Baltimore, Md., U. S. A.

Foreign Agents:—Ludw. Loewe & Co., Berlin, Germany. Ing. Ercole Vaghi, Milan, Italy. Chas. Churchill & Co., London, England.



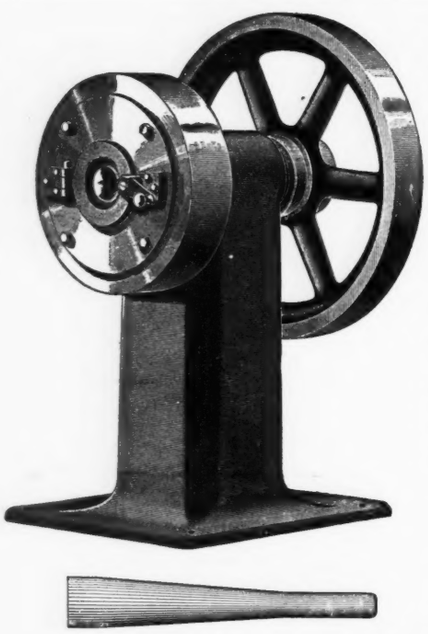
The Automatic Threading Lathe

Saves money on all threaded work. Does difficult threading accurately at highest speeds. Produces from 25 to 100% more threading in a given time than the engine lathe. Allows one man to attend several machines. Cuts internal, external, straight or taper threads without special tools.

WRITE FOR CATALOGUE

AUTOMATIC MACHINE COMPANY, Bridgeport, Conn.

AGENTS—Alfred H. Schutte, Schuchardt & Schutte, C. W. Burton, Griffiths & Co., of London, England. Marshall & Huschart Machinery Co., of Chicago, Ill., and Motch & Merryweather Machinery Co., of Cleveland, O. Vandyck Churchill Co., Philadelphia, Pa.



Example of Metal Shell Tapering.

Are You Alive to the Value of Cold Swaging?

The tapering and reduction of all kinds of bars and tubing, from bicycle frames and buggy axles down to jewelers' wire, can be done better, quicker and more economically with the

DAYTON SWAGING MACHINE

than by any other method.

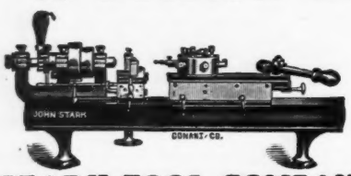
The process of swaging eliminates waste of material and gives the metal qualities of strength solidity and increased elasticity otherwise unattainable.

Ask us for specific examples of efficiency and our catalogue "The Modern Art of Swaging."

The Excelsior Needle Co.
Torrington, Conn.

Coventry Swaging Co., Ltd., White Friars Lane, Coventry, England, Agents for Great Britain. Fenwick Freres & Co., 8 Rue de Rocroy, Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

A STARK BENCH LATHE



Will soon show its worth in the shop where accurate work is essential.

STARK PRECISION TOOLS

are made from finest materials, by skilled workmen and from up-to-date designs.

Ask for catalogue B.

STARK TOOL COMPANY, Waltham, Mass., U. S. A.

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The Krieger System

The Krieger System Trebles Your Boring Equipment
Ten times the money spent remains in your Pocket when you buy Krieger's Boring-tool-holders Boring-tools & Boring-bars
Saves Time, Labor and Money

GIVE THESE TOOLS A TRIAL AND BE CONVINCED.

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KRIEGER TOOL & MFG. CO.
83-91 W. Randolph St., Chicago, Ill.

BRISTOL COUNTERS

The Counters that Count—and Count Right.

Simple, few parts, no spring. Adaptable for any machine, cannot be tampered with, and provide an infallible record of the day's output, which is automatically registered. Strong, convenient and compact. Ask for Catalogue No. 27.

THE C. J. ROOT COMPANY, Bristol, Conn.

Sames' Pocket-Book of Mechanical Engineering

The most useful reference manual published on the subject, because it is up-to-date and is years in advance of any similar compilation. No mechanical engineer, designer or draftsman should be without it. Third edition, morocco, $2.00, postpaid. Write for circular.

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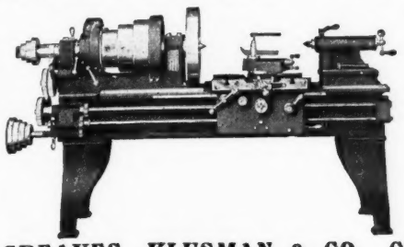
STANDARD ENGINE LATHES



5 STEP STANDARD

3 STEP DOUBLE BACK-GEARED

GREAVES, KLUSMAN & CO., CINCINNATI, OHIO, U. S. A.

The Variety of Work that can be Handled with

The Knight Drilling and Milling Machine

will amaze you. A combined drill press and vertical milling machine, it will save from 20 to 50% in time on making dies, patterns, models, etc., or on tool room or experimental work.

Ask for the circular

THE W. B. KNIGHT MACHINERY CO.
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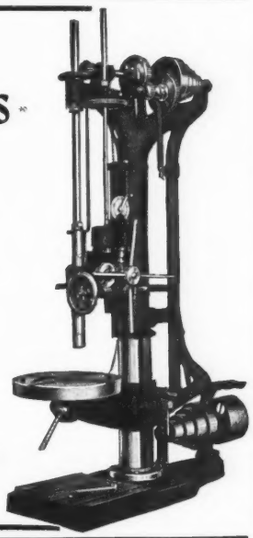
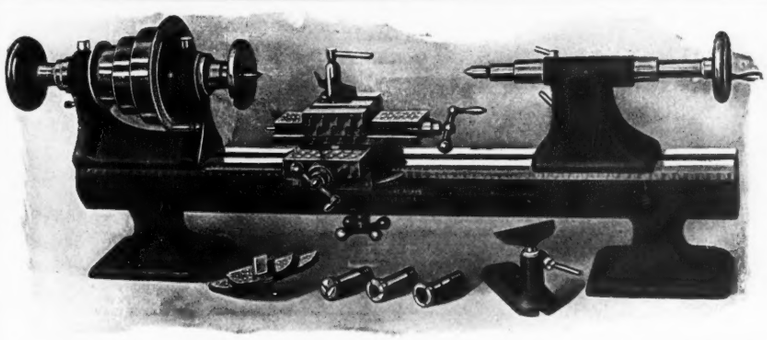
THE EQUIPMENT OF Aurora Upright Drilling Machines

includes every device for speed, convenience and efficient service. They are built for modern drill work and fitted with back gears, power feed, automatic stop and geared tapping attachment. Can be furnished with belt or motor drive as desired. Are made in sizes from 14″ to 44″ swing, have the time saving features so essential to present day manufacturing and the added advantage of moderate prices.

Glad to mail a Catalogue.

THE AURORA TOOL WORKS
Aurora, Ind., U. S. A.





A WALTHAM BENCH LATHE

8″ swing, $\frac{5}{8}$″ chuck capacity clear through. Unusually heavy slide rest. Attachments for turning, grinding, milling, screw cutting.

Ask for latest catalogue.

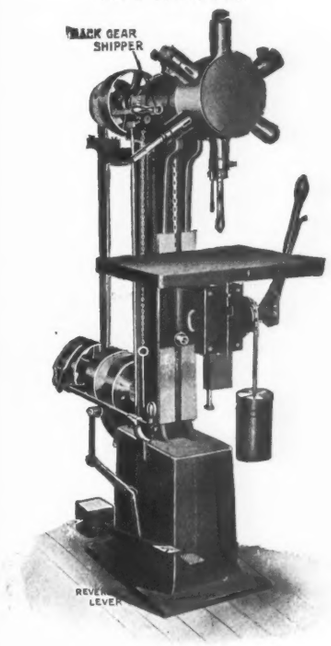
Waltham Machine Works, Newton St., Waltham, Mass.

QUINT TURRET DRILLS

Built in Four Sizes Thirty-Five Different Styles

For Boring, Drilling, Reaming and Tapping all Kinds of Metal Work

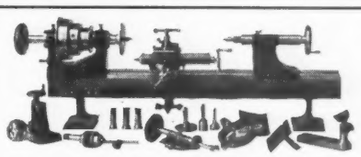
No. 2 IMPROVED



Ratchet lever feed, back gears, and reverse motion for tapping. Only the spindle in use rotates. Made with either 6, 8, 10 or 12 spindles.

A. E. QUINT, Hartford, Conn.

FOREIGN AGENTS: Ph. Bonvillain and E. Ronceray, Paris, France. C. W. Burton, Griffiths & Co., London, England. Haelbig, Wagner & Co., Dresden, Germany. G. Koeppen & Co., Moscow, Russia.



A PRECISION BENCH LATHE

7 in. swing, 32 in. bed, 16 in. between centers.

For tool room, experimental, jig, die and fine machine work there is no other tool made that gives such gratifying results as the Elgin Precision Bench Lathe. It is essentially practical, sturdy in its make up, and is

Built with the Accuracy of a Watch

The Elgin Tool Works, Elgin, Ill., U.S.A.

Complete Index to
Machinery's Data Sheets
will be sent on request.

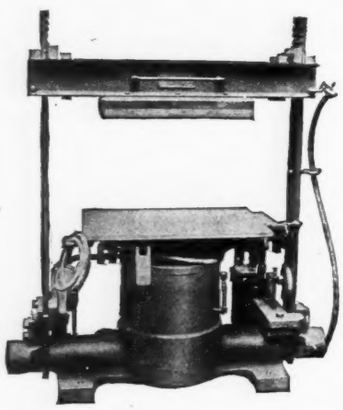
Heat Can't Affect Dixon's Flake Graphite

Even the highest temperatures encountered in steam and gas engine cylinders do not alter Dixon's Flake Graphite nor diminish its lubricating powers. As an assistant to oil or grease, especially in this hot weather that quite markedly affects many oils and greases, Dixon's Flake Graphite is almost indispensable.

Write for free sample 101-C.

Joseph Dixon Crucible Co., Jersey City, N.J.

Tabor Molding Machines



Cut shows 13" Cylinder Power Squeezer designed to squeeze the sand to the proper density instead of ramming by a blow.

Machine is adapted for use with Vibrator Frame, Paraffine Board or Plated Pattern.

Write for Catalogue.

The Tabor Manufacturing Co.

18th and Hamilton Streets

PHILADELPHIA, PENNSYLVANIA

TECHNICAL BOOKS

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TRUMP BROS. MACHINE CO., - *Manufacturers,* - Wilmington, Del.

SOLD BY: De Fries & Co., Dusseldorf, Germany. Chas. Churchill & Co., Ltd., London, England.

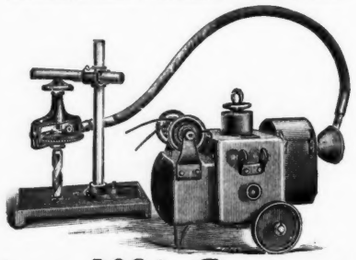
Combination of

Stow Flexible Shaft

and

Multi-Speed Electric Motor

Portable Drilling, Tapping, Reaming, Etc.



Stow Mfg. Company

Binghamton, N. Y.

Selig, Sonnenthal & Co., General European Agents, London, Eng.

The Robinson Grinder

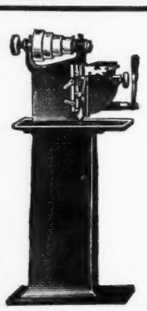
A combination machine with capacity for surface grinding, cutter grinding, twist drill grinding and general tool grinding.

An inexpensive machine with the special features usual only in the larger and more costly grinders.

Ask for price and particulars.

The Robinson Tool Works

Waterbury, Conn.



HAND MILLING MACHINE

Adapted for small and duplicate work, built from best materials and with unusual weight and rigidity for its size. Table has long bearings, adjustments can be made without wrenches or other tools and machine is fitted with draw-in spindle and collet or chuck for arbors or end mills.

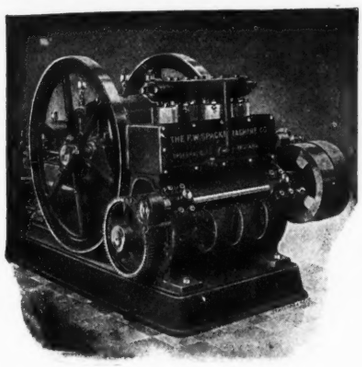
First class in every particular—send for circular.

DALIN BROS., Rockford, Ill.

AIR FURNACE IRON OR ACID OPEN HEARTH STEEL

Castings up to 100 Tons in One Piece Our Specialty

CHAMBERSBURG ENGINEERING CO., Chambersburg, Pa., U.S.A.

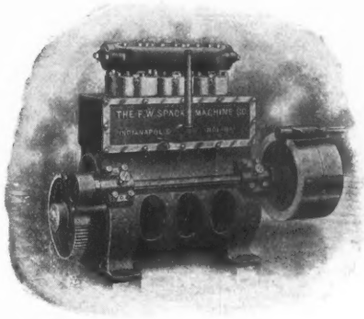


AIR COMPRESSORS

Single or Three Cylinder Styles. Belt or Motor Driven

We build Air Compressors with capacities ranging from 1 to 100 cubic feet free air per minute.

Write for full particulars.



The F. W. Spacke Machine Co., Indianapolis, Ind.

GEAR CUTTING SPROCKET CUTTING

Special department for this division of our business. Estimates furnished.

GRAPHLIO

A Crystalline (flake) Graphite ground to an impalpable powder, absolutely gritless, and so prepared that it will remain in suspension in any oil.

Mixed with your oil, it covers the bearing surfaces with a thin film of graphite, and prevents hot bearings, seizing, etc. The only graphite that does not settle in your oil.

Send for free sample B-4.

WALTER D. CARPENTER COMPANY

39 Cortlandt Street, NEW YORK, N. Y.

COUNTERS

Did you ever stop to think that it costs money to count the number of pieces made, not to speak of what mistakes cost?

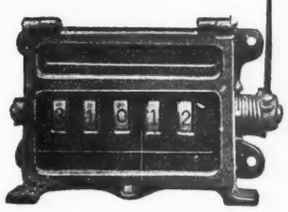
Our No. 4207 Counter costs $5.00 and the cost stops there. It doesn't make mistakes.

Size 5¾ in. x 4¾ in. x 2½ in. Weight 4¾ lbs.

It is a check on inaccuracy—not on dishonesty. Can be attached to presses (both printing and punch) and all automatic machinery.

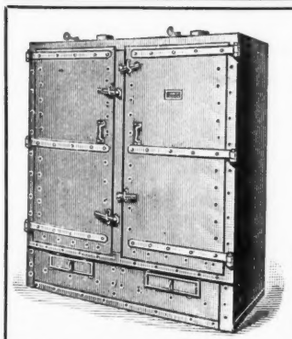
No key required for resetting for each run.

Figures large—black enamelled—easily read.



DURBROW & HEARNE MFG. COMPANY

11 Wooster Street New York City, N. Y.



THE STEINER JAPANNING AND DRYING OVEN

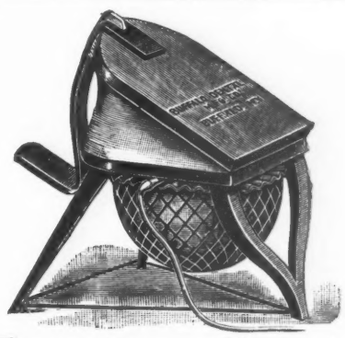
Designed to meet special conditions. Heated by gas and adaptable for many lines of manufacture. Special burners used for drying materials containing much moisture.

Ovens for

Bronzing, Japanning, Baking, Enameling, Drying.

Made in any size required. Send for Catalogue.

EMIL E. STEINER, 58 Union St., Newark, N. J.



Experience Counts

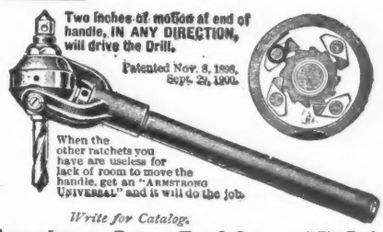
We've been making foot blowers for over a quarter of a century. To determine the economy or extravagance of the material we use, we have time and again tested stock leathers, soft woods and cheaper rubber. Results go to show that the material we employ —**selected** leather, **hard** wood and **pure Para** rubber disks—are best alike for buyer, seller and maker. Best because they produce a Blower which lasts longest and gives satisfaction every minute of the time it is used. There's no skimping or saving in the make up of "BUFFALO DENTAL MFG. CO.'S BLOWERS." Why shouldn't they be the best on earth?

Look for the name stamped in the wood. Catalogue "BM" tells about Blowers, Blowpipes and Furnaces. Tell us you are interested.

Buffalo Dental Manufacturing Co.

BUFFALO. N. Y., U. S. A.

You Can't Get Stuck with this Ratchet.


Two inches of motion at end of handle, IN ANY DIRECTION, will drive the Drill.
Patented Nov. 8, 1898, Sept. 26, 1899.
When the other ratchets you have are useless for lack of room to move the handle, get an "ARMSTRONG UNIVERSAL" and it will do the job.

Write for Catalog.

Armstrong Bros. Tool Co., "The Tool Holder People."

113 N. Francisco Ave., CHICAGO, ILL., U. S. A.

SEE OUR TOOL HOLDER AD. PAGE 112.

NO MORE CUSS WORDS IN THE DARK

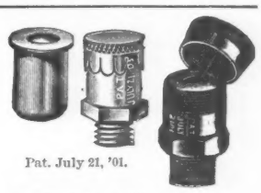
SKUNK UM UN D PL S

IF YOU CAN GET YOUR HAND ON IT YOU CAN PUT THE OIL IN

SEND FOR SAMPLES AND PRICES

European Agents, CHARLES CHURCHILL & CO., London, Eng.

BAY STATE STAMPING CO., WORCESTER, MASS.



Pat. July 21, '01.

BENNETT HANDY OILERS

BARGAINS NEW AND SECOND HAND MACHINERY TOOLS AND SUPPLIES

Second-Hand Machine Tools

Located at Boston, Chicago & New York.

LATHES.

- 7" x 32" P. & W. Plain.
- 16" x 6' Plain, Flather.
- 16" x 6' C. R. Prentice.
- 16" x 6' Fitchburg, compound and taper.
- 16" x 6' Putnam Motor drive, 110 V.
- 16" x 6' Putnam Motor drive, 220 V.
- 16" x 6' C. R. Prentice.
- 16" x 8' with taper, Reed.
- 18" x 8' Plain Rest, Flather.
- 18" x 8' Putnam Motor drive, 110 V.
- 18" x 10' Geared Head, Draper.
- 22" x 16' Shafting. Lathe, Fitchburg.
- 24" x 8' C. R. Putnam, not screw cutting.
- 24" x 12' Comp. Putnam Motor, 110 V.
- 28" x 15' C. R. Blaisdell.
- 30" x 12' Comp. and Taper, Tri. Gd., Johnson.
- 48" x 10' Face Plate Lathe.
- 50" x 30' C. R. Pond, Tri. Gd.
- 13" Turret Lathe, Gisholt.
- 28" Turret Lathe, Gisholt.
- 24" Conradson Turret Lathe.

MILLING MACHINES.

- No. 00 Bench P. & W. Precision Miller.
- Brainard Index Miller.
- No. 0 Plain B. & Sharpe
- No. 0 Plain Carter & Hakes.
- No. 2 Plain Garvin.
- No. 3 Plain Garvin.
- No. 4½ Plain Becker-Brainard.
- No. 4 Plain B. & S. Old style.
- No. 14A Plain Garvin.
- No. 33 84" Planer, Type Becker B.
- No. 1 Univ. LeBlond.
- No. 2A Univ., Owen.
- No. 4 Univ., B. & S. Old style.
- No. 2 Lincoln, P. & W.
- No. 5 Vertical, Becker.
- No. 2 Single Spindle Profiler, Garvin.

RAILROAD MACHINERY.

- Bement Single Axle Lathes.
- Bement Double Axle Lathes.
- No. 2 Niles Double Axle Lathes.
- No. 3 Putnam Extra Heavy Double Axle Lathe.
- 46" Bement Double Car Wheel Lathe.
- 36" Baker Bros. Car Wheel Borer.
- 36" Car Wheel Borer. Niles.
- 48" Car Wheel Borer, Bement.
- 300 tons 48" Niles Hydrostatic Wheel Press.

PLANERS AND SHAPERS.

- 15" Crank Planer, Blaisdell.
- 16" x 16" x 4' P. & W.
- 17" x17" x4' Whitcomb.
- 22" x 22" x 6' Putnam.
- 24" x 24" x 6' Putnam. 110 V. Motor.
- 26" x 26" x 6' Pond.
- 30" x 30" x 24' 2 hds., Sellers.
- 48" x 48" x 9' 1 hd., Hewes & Phillips.
- 72" x 72" x 24' 3 hds., Bement.
- 72" x 72" x 24' 4 hds., Sellers.
- 18" x 9' Bed Double Head Shaper, Cincinnati.
- 20" Pillar Shaper, Hendey.

BORING MILLS.

- 37" 2 hds., Vertical, Bullard.
- 21' 3 hds., Vertical Motor Drive, Pond.
- 36" Turret Borer, Colburn.
- 36" Vertical Turret Borer, Brown & Sharpe.
- 96" Swing, Special Cylinder Borer.

TURRET MACHINERY.

- ¾" 00 Garvin Wire Feed.
- ½" No. 1 P. & W. Wire Feed.
- ⅝" No. 2 P. & W. Wire Feed.
- 1¼" No. 3 B. & O. Wire Feed, geared head.
- 2" No. 3 P. & W. Wire Feed.
- ¼" No. 0 Hartford, Automatic Stud Machine.
- ⅝" Cleveland Automatic Stud Machine.
- 5/16" No. 0 P. & W. 2-spindle Screw Machine.
- ¼" No. 00 P. & W. Automatic Screw Machine.
- ⅜" No. 1 Acme Old Style, four-spindle Automatic.
- 21/32" No. 2 Old Style B. & S. Automatic.
- ¼" No. 1 P. & W. 2-spindle Automatic.
- ½" No. 1 Spencer, Single Turret.
- ½" No. 1 Spencer, Double Turret.
- ¾" No. 2 P. & W. Automatic.
- ¾" No. 2 P. & W. 2-spindle Automatic.
- 1" No. 2 Hartford Automatic.
- 1¾" P. & W. Automatic.

MISCELLANEOUS.

- 30" Draw Stroke Slotter, Baker Bros.
- No. 6 Bulldozer, Williams-White.
- No. 2 Cutter Grinder, B. & S.
- 5' 6" Radial Drill, Niles.
- Single Spindle Sensitive Drills.
- Multiple Spindle Sensitive Drills.
- Upright Drills, 24" & 32".
- Adjustable Multiple Spindle Drills.
- No. 10-10 Spindle P. & W. Drill 1½" Cap.
- No. 11-10 Spindle P. & W. Drill ¼" Cap.

Send for New List No. 16.

Miscellaneous Department.

Niles-Bement-Pond Company,

111 BROADWAY, NEW YORK.

MACHINE TOOLS

Condition Guaranteed.
Send for Yellow List No. 101.

LATHES

- 84"x40' Putnam, Rod Feed.
- 70"x24' Screw Cutting Lathe.
- 60"x16' Gap Lathe, Rod Feed.
- 3-40"x18' New York Safety.
- 40"x22½' Pond.
- 36"x12' Putnam.
- 28"x20' Pond.
- 24"x12' Flather.

PLANERS

- 84"x84"x27' Lowell, 2 Heads.
- 84"x84"x24' Putnam, 1 head.
- 36"x14' Detrick & Harvey Open Side, 3 Heads.
- 36"x36"x17' Sellers.

HAMMERS

- 1100 lb. Bement Single Frame Steam Hammer.
- 1000 Chambersburg Steam Drop.
- 800 lb. Pratt & Whitney Board Drop.

SHAPERS

- 24" Gould & Eberhardt.
- 18" Back Geared American.
- 20"x30" Pedrick & Ayer Open Side Shaper.
- 18" Ohio Crank.
- 16" Back Geared Cincinnati.

SPECIAL

- 36" Becker-Brainard Automatic Gear Cutter.
- 30" Bullard Turret Head Boring Mill.
- No. 2 Becker-Brainard Plain Miller with Vertical Attachment.
- No. 2½ Bath Universal Grinder, complete.
- 3—24" Swing Potter & Johnston Turret Lathes.
- 4' Universal Radial Drill Co.'s Radial.

Full stock of smaller tools for the ordinary machine shop always on hand.

FRANK TOOMEY, 127-131 N. Third St., PHILADELPHIA, PA.

FRY DRAUGHTING TABLES

STANDARD for years. None better at any price—Style B, as shown, is very complete—has foot rest, swing drawer and sketch box, and is suited for sketch, perspective and careful work. Strongly made from best materials; adjustable iron standards; folds into small compass when not in use. Write for Catalog of Draughting Room Furniture.

FRITZ MFG. CO., Grand Rapids, Mich.
60 Alabama Street.

HAVE YOU

A RAWHIDE Mallet or Hammer

IN YOUR SHOP?

No machine shop, engine room or factory complete without one.

HARD BUT FLEXIBLE

No battered up bolts, pins or machine parts where used.

WE MAKE THE BEST

The Chicago Rawhide Mfg. Company

75-77 E. Ohio St., CHICAGO, ILL.

Scores of High-Class Low-Priced Tools

AND OTHER

Scores of Low-Priced High-Class Tools

Great opportunities these—especially in BIG TOOLS

So many fine machines in this last outfit, it's hard to select the best for mention here.

LARGE LATHES

- 86" Swing, 27' bed, spindle, front bearing 11" diam. Cone 6 steps, 6" belt, heavy Modern style, adapted for heaviest duty, "Worcester."
- 66"x36' Triple-geared "Bement."
- 60"x21' Triple-geared, "Fifield."
- 54"x24' Triple-geared, "Worcester."
- 52"x18' "Fifield."
- 39"x16' Triple-geared, "Putnam."
- 38"x12' Triple-geared, "Gleason."
- 36"x21' "Putnam."
- 33"x12' Triple-geared, "New Haven."
- 28"x14' Triple-geared, "Harrington."
- 26/44"x14' Geared Plate with Motor-drive, equipment, complete with motor, "McCabe."

SMALL LATHES

- 10" Tool-makers' Lathe. Taper, Chucks. Hollow spindle, Cpd.-rest. "Pratt & Whitney."
- 13"x5' Ames.
- 14"x8' Drawing-in att. Quick-change Hendey.
- 16"x6' Porter.
- 16"x10' Auto stop, "Pratt & Whitney."
- 18"x8' Taper attachment, "American."
- 18"x9' Auto stop, "Draper."
- 20"x8' Chuck-fitted, "Pond."
- 24"x12' heavy, "Sellers."
- 26"x12' heavy-truss form of bed, "Bogert."
- 28"x14' heavy, "Worcester."
- 28"x16' heavy, "Fay & Scott."

BIG PLANERS

- 48"x18', four heads, "Gray."
- 52"x16', two heads, "Niles."
- 50"x16', four heads, "Sellers."
- 42"x18', two heads, "New Haven."
- 42"x8', one head, "Pease."
- 36"x10', one head, "Putnam."
- 32"x10', two heads, "Pond."

OTHER PLANERS

- 24"x5', one head, "Pond."
- 26"x6', one head, "Whitcomb."
- 27"x6', one head, "Ohio."
- 30"x8', one head, "Putnam."
- 30"x12', one head, "Newark."

RAILROAD TOOLS

- Double-head Driving-wheel Lathe, 79" Swing, "Niles."
- Double-head Driving-wheel Lathe, 60" Swing, "Niles."
- Car-wheel Grinder, Double-head, for handling both wheels, one operation, "Springfield."

MILLING MACHINES AND SCREW MACHINES

- Millers—
  - Heavy, "Knee type" Pedrick & Ayer. Table 48" long.
  - No. 4 Universal, all atts., "Kempsmith."
  - No. 5 Plain, 48" Table feed, "Brown & Sharpe."
  - No. 2 Plain, 20" Table feed, "Oesterlein."
- No. 2 Plain, 26" Table feed, "Brown & Sharpe."
- No. 2½ "Manufacturers' style" Quick-change "Hendey."
- Lincoln Miller, with Screw-feed, "Ames."
- Screw Machines—
  - 2⅝" full automatic, "Cleveland."
  - 1¼" Wire feed, "Warner & Swasey."

TURRET MACHINERY

- 32" Upright Boring Mill, with Turret head, "Rogers."
- 28" Semi-automatic Turret Lathe, "American," Gisholt type.
- 2x24" Flat Turret Lathe, "Jones & Lamson."

MISCELLANEOUS

- Gear Cutters, 30" full-automatic Spur and Bevel, "Gould & Eberhardt."
- Gear Cutters, 22" full-automatic Spur and Bevel, "Brown & Sharpe." 2, cap'y, 12"x30".
- Universal Grinders, No. 1, cap'y, 8"x16".
- Slotter, 12" stroke, "Bement."
- Pipe Machine, 2¼" to 8", "Saunders."
- Key-seater, cap'y. 1½" to 18", "Morton."
- Bolt Cutter, 1" "Acme," lots of extras.
- Cutting-off Machine, 2" "Betts."
- Steam Hammer, 1,000 lb., "McDougall-Potter."
- Steam Hammer, 250-lb. "Bement-Niles."

BOILER-SHOP TOOLS

- 96" gap Hydraulic Riveting Outfit, complete equipment, including Crane, Pump, Overhead Hoist, Accumulator, etc., "Bement-Niles."
- 10' Bending Rolls, Hinged housing, "Hilles & Jones."
- 48" Gap Punch & Shears, cap'y. 2"x1", "Cleveland."

J. J. McCABE, 80 CHURCH STREET **NEW YORK**

REFITTED MACHINE TOOLS

BORING MACHINES.
1—30″ Bullard.
1—37″ Bridgeport, 1 head.

DRILL PRESSES.
1—6-spindle Quint Turret.
1—33″ Bement-Miles.

DRILL PRESSES--RADIAL.
1—24″ Fosdick, National Type.

GEAR CUTTERS.
1—Grant-Lees Hobbing Machine.
1—30″ x 8″ Brainard spur.
1—36″ x 9″ x 5-p Gould & Eberhardt.
2—50″ x 11″ x 3-p Gould & Eberhardt.

GRINDERS.
1—"A" Yankee Drill Grinder.
1—Leland & Faulconer, wet.

HAMMERS.
1—60 lb. Bradley Cushion Helve.
1—200 lb. Bradley Helve.

LATHES.
1—14″ x 5′ Windsor, friction countershaft.
1—14″ x 6′ Le Blond quick change gear.
1—14″ x 8′ Flather.
1—16″ x 6′ Reed, belt feed, plain rest.
1—16″ x 6′ Lodge & Shipley, quick change gear.

LATHES.
1—18″ x 6′ Lodge & Shipley, quick change gear.
1—20″ x 8′ Flather, comp. rest.
1—22″ x 10′ Lodge & Shipley, quick change gear.
2—22″ x 12′ Lodge & Shipley, quick change gear.
1—22″ x 12′ Walcott.
1—24″ x 8′ Flather.
1—24″ x 10′ Lodge & Barker.
1—24″ x 12′ Lodge & Shipley, quick change gear.
1—24″ x 16′ Lodge & Shipley, quick change gear.
1—26″ x 12′ Reed.
2—27″ x 10′ Lodge & Shipley, quick change gear.
1—27″ x 14′ Lodge & Shipley, quick change gear.

LATHES--POLISHING.
1—No. 3 Diamond, 52 x 1¼ spindle.
1—No. 7G Diamond, 46 x 1¼ spindle.

MILLING MACHINES.
1—No. 4 Cincinnati, all feeds, plain.
1—42″ x 24″ x 8′ Ingersoll Slab.

PLANERS.
1—10″ Bush Crank.
1—20″ x 20″ x 4′ Wheeler, 1 head.

PLANERS.
1—26″ x 26″ x 10′ Powell, 2 heads.
1—36″ x 36″ x 10′ Gray, 2 heads.
1—42″ x 36″ x 14′ Cincinnati, 2 heads.

PRESSES.
2—No. 20 Bliss.
1—DAG No. 4 Ferracute.
1—D75 Ferracute.
1—No. 62 Toledo.
1—No. 8 Greenerd Arbor.

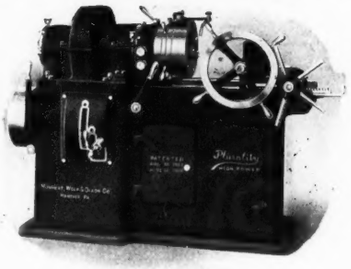
SAWS.
1—3½″ Burr.
1—6″ Newton.
1—Millers-Falls Hack.
1—26″ Crescent Band.

SHAPERS.
1—14″ Lodge & Davis.
1—16″ Gould & Eberhardt.
1—18″ Steptoe.
1—20″ Hendey.
1—24″ Gould & Eberhardt.
1—24″ Hendey.
1—24″ Potter & Johnston.
1—26″ Cincinnati, triple geared.
1—28″ Hendey.
1—32″ Gould & Eberhardt.
1—34″ Walcott, shifting belt.

TURRET LATHES.
1—No. 5 Warner & Swasey.
1—22″ Bullard "H" Machine.
1—26″ Universal, chuck fitted.

THE MOTCH & MERRYWEATHER MACHINERY CO.
707-715 Lakeside Ave., N.W., Cleveland, O. 1025 Majestic Bldg., Detroit Branch. 1014 First Nat'l Bank Bldg., Cincinnati Branch.

Plurality High Power Bolt Cutters



Constant speed gear drive; Powerful **Quick Change** machines that will save money on every bolt cutting job you can handle. *Durability of the dies* and *low cost of maintenance* are further good points. One set of **Plurality Dies** will do the work of twelve sets of other makes.

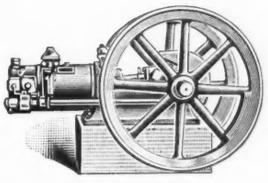
— Ask for new leaflet. —

Mummert, Wolf & Dixon Co.
Hanover, Pa.

MILWAUKEE ENGINE LATHES
Ask for Special Circular
Milwaukee Machine Tool Co., - Milwaukee, Wis

ENGINEERS KNOW OTTO ENGINES

As the standard of Gas and Gasoline Engine construction. The colleges endorse them, Insurance companies favor them.



Countless users value them for their reliability, economy, wearing qualities and little maintenance cost. Otto Engines are as reliable as steam, much cheaper to run, and do not require expensive help to operate them. They contain features all their own which no purchaser can afford to overlook. *Tell us your needs and we will send the proper catalogue.*

The Otto Gas Engine Works, Philadelphia, Pa.

Don't Scrap Defective Castings

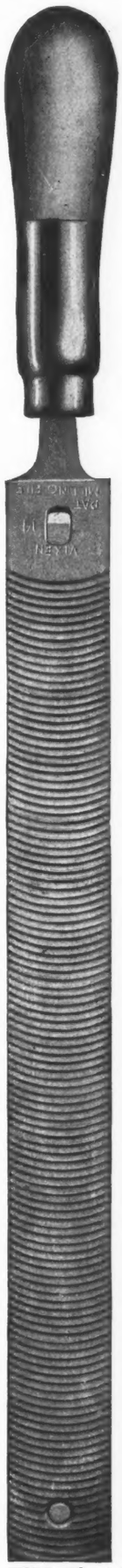
Blow holes, cracks and other defects can be cured to stay cured by using this cement. Tests have proven that such defects filled with

National Iron Filler Cement

pass every inspection. It becomes a part of the iron and hard as the iron itself.

Get Sample 109-P.

The S. OBERMAYER CO.
Everything You Need in Your Foundry
Cincinnati Chicago Pittsburgh
180



This is —the— Famous "VIXEN" Patent HAND MILLING TOOL

—— and it did not become "famous" by accident, — quite otherwise.

The secret of its instant — and permanent grip—upon the esteem of all Mechanics who GIVE IT — A TRIAL may be traced to this combination of desirabilities.

To—Its POSITIVELY FEROCIOUS APPETITE for every form of abrasive work that can be done by hand—

To—The fact, that IT WILL DO AT LEAST 5 times AS MUCH WORK AS THE "VERY BEST - EVER" — FILE.

To—The fact that it will outwear from 5 to 10 such good-as-can-be FILES—and

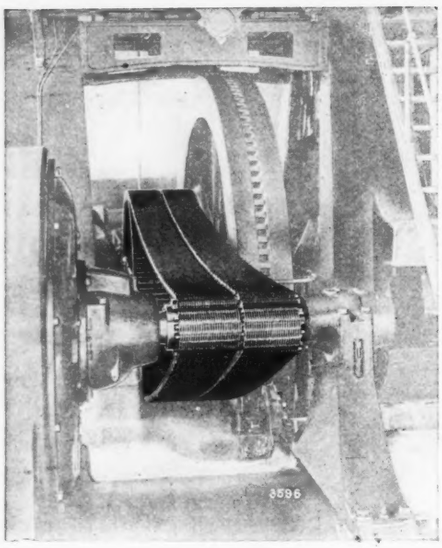
To—The fact that after the VIXEN MILLING TOOL becomes dull it CAN be SHARPENED MANY TIMES at a nominal cost "per-time," and without drawing its temper.

Possibly you have not yet seen the VIXEN HAND MILLING TOOL? in which case, it would be wise for you to order a Sample of the Agent nearest to you—(Shall we send you his name?) and then try it on the VERY TOUGHEST JOB YOU CAN THINK OF. It is the "Verdicts" resulting from such "*trials*" that are spreading — VIXEN — FAME far and wide.—

For the softer Metals and Materials—we recommend the coarse cut —For the Harder ones the Fine cut "VIXEN" TOOL.

Manufactured by

NATIONAL FILE AND TOOL CO.
2105 Allegheny Ave.
No. 2. **PHILADELPHIA, PA.**



RENOLD
(MAXIMUM)
CHAIN

works unflinchingly, giving full value in power-transmission—and does it so quietly and evenly that the work of the tool reaches a proportionately high point.

The details are given very fully in Booklet "Y" and Bulletins 50, 52, 57, 58; any or all sent for the asking.

LINK-BELT COMPANY
Philadelphia Chicago Indianapolis

NEW YORK 299 Broadway | PITTSBURGH 1501-2 Park Bldg. | BOSTON 84 State St. | BUFFALO 601 Ellicott Sq. | ST. LOUIS Missouri Trust Bldg.
SEATTLE—439-40 New York Block

"You Want the Best—Buy of Us"

INCOMPARABLY SUPERIOR
are the RESULTS obtained with
"TOLEDO"
FORGING PRESSES and FORGING EQUIPMENT

No. 94 E. will forge sledges, hammers, axes, mattocks, pickeyes, etc., in one or several heats. Tool holders easily and quickly removed and replaced with other special tools.

Presses, Shears, Hammers, Dies and Special Machines for all classes of work—all bear the stamp of QUALITY.

THE TOLEDO MACHINE & TOOL CO.
TOLEDO, OHIO, U. S. A.

AGENTS: Ludw. Loewe & Co., Berlin, Germany.
Selig, Sonnenthal & Co., 85 Queen Victoria St., London, Eng.

FORGINGS
For Machinery Builders

We have Steam Hammers, Drop Hammers, Trip Hammers and Upsetters.

The Machinery Forging Co.
CLEVELAND, O.

A 500 to 1000% INVESTMENT OUGHT TO INTEREST YOU

The above is what a Curtis Sand Blast will do for you.

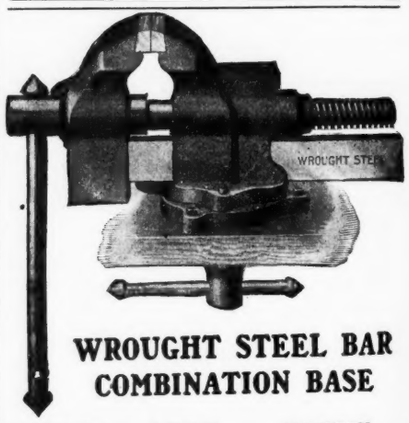
Automatically screens the sand and removes the dust.

Requires absolutely less sand, power, labor or repairs and does more work than any competing make.

High priced sand blast hose not needed and hose can never become choked.

Operator need not stop work during time hopper is being filled.

CURTIS & CO. MFG. CO., St. Louis, Mo.
NEW YORK OFFICE: 30 Church Street.



WROUGHT STEEL BAR COMBINATION BASE

MERRILL BROS., MASPETH, NEW YORK, N. Y.

Save Money

by having one of our Centering Machines properly located. It has surprised many, why not you? Give it a little thought.

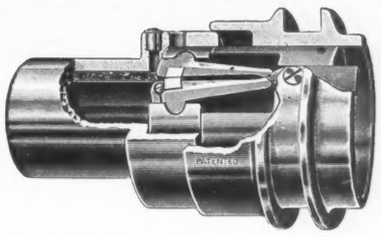
THE PHOENIX MFG. CO. 32 UNION PLACE, HARTFORD, CONN.

The King Machine Tool Company.
CINCINNATI, OHIO, U. S. A.
VERTICAL TURRET BORING AND TURNING **MACHINES**

THE JOHNSON FRICTION CLUTCH

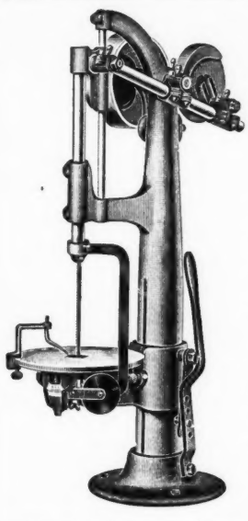
Cuts Out that Constant Trouble with Countershafts

because it permits running your machines direct from the line shaft, saving power, the expense of equipment—belts, pulleys, etc.—and adds light, air and cleanliness by eliminating overhead belts. The clutch for all high speed machinery—light in weight, simple, compact, smooth running. Ask for Booklet "A."



FOREIGN AGENTS—Efandem Co., 246a Corporation St., Birmingham, Eng., for Great Britain. Canadian Fairbanks Co., Montreal, Toronto, Winnipeg and Vancouver, for Canada. Glaenzer, Perreaud & Thomine, No. 1 Avenue de la Republique, Paris, for France. Bieberstein & Goedicke, Ferdinanstr. No. 25—7 Amerikahause, Hamburg, for Germany. Wilh. Sonesson & Co., Malmo, Sweden, for Norway, Sweden, Finland and Denmark.

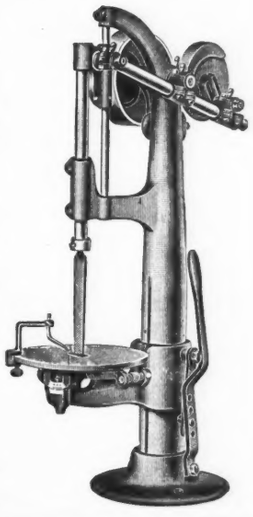
THE CARLYLE JOHNSON MACHINE CO. HARTFORD, CONN.



The Simplex Combination Bench Filer and Metal Hack Saw

is adapted for the most particular work — the finest, closest and most accurate filing, and will accomplish the work in a fraction of the time required by hand filing.

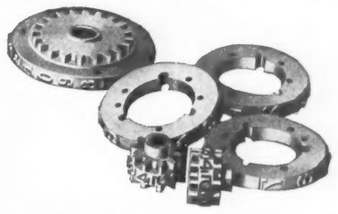
It is simple, easily adjusted and operated, and with a few special fixtures is adapted for the economical handling of a great amount of work ordinarily done on the milling machine.



Write for our book "Machine Filing"—sent free on request.

The Simplex Mfg. Company
90 West Street, NEW YORK

Numbering and Printing Wheels

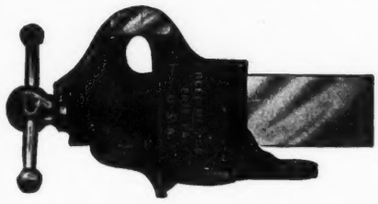


THIS class of work calls for not only extreme accuracy, but style and legibility. The clear-cut letters and figures shown on the work testify to the skill of our engravers, and the finish of the completed parts plainly indicates that only the most competent workmen are employed by us. There is no question as to the durability of the goods as that has been proved by years of continuous use.

Write for our new booklet C describing Franklin Die-Castings and the Process; it is interesting.

Franklin Manufacturing Co.
203 South Geddes Street
Syracuse N Y

The Three R's in Vise Education



"Reed" on a machinists' vise stands for
Reliable construction,
Right design and satisfactory results

Ask your dealer for a Reed Vise and take no other. Sold under the strictest guarantee.

Catalogue H on request.

REED MFG. COMPANY, Erie, Pa.

FOR SALE

OLSEN HARDNESS TESTING MACHINE

Made by
Tinius Olsen & Co., Philadelphia, Pa.

Condition: As good as day it left factory.
Reason for selling: Not adaptable for work intended.

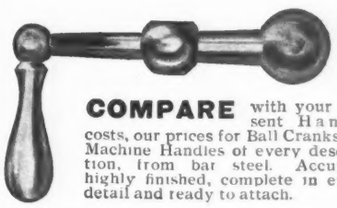
ADDRESS
"Testing Machine" care of MACHINERY
49 Lafayette Street, New York City

NEW ADJUSTABLE REAMER

Interchangeable Half Round Blades.

1 inch to 6 inch. Send for sample reamer.

Lapointe Machine Tool Co., Hudson, Mass.



COMPARE with your present Handle costs, our prices for Ball Cranks and Machine Handles of every description, from bar steel. Accurate, highly finished, complete in every detail and ready to attach.

The Cincinnati Ball Crank Company
Cincinnati, Ohio
Successors to this dept. of the SCHACHT MFG. CO.

The Unit System of Self-Education

is described on pages 131-132-133-134 in the advertising section of this issue.

The Russell Anti-Friction Drill Chuck

Saves enough in time and drills to pay for itself in a few months use--

Holds the drill so there is no possibility of twisting or slipping—no broken drills or damaged work.

Self-tightening and automatic—can be adjusted by hand without recourse to key, wrench or other mechanical device.

Time saving, tool saving and the one successful chuck for automatic machines.

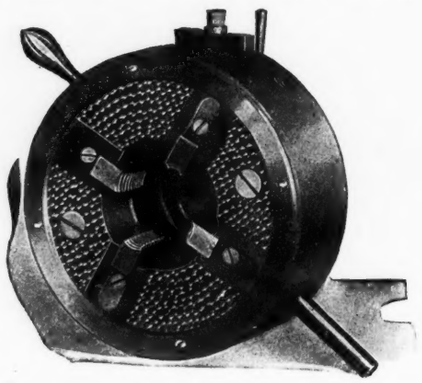
Accuracy is another Russell strong point.

Write for the Catalogue.

Russell Anti-Friction Drill Chuck Co.
Elmira, New York, U. S. A.

Distributing Agents for Canada: The General Supply Company of Canada, Ltd., Ottawa.

30 to 50 Per Cent. Faster



You can cut screw threads from 30 to 50 per cent. faster by using our

Self-Opening Dies.

Moreover, with these dies it is unnecessary to back out and possibly damage the tool, the finished thread, the machine, belts or countershaft. They cut any length thread and will work flush to a shoulder.

Write for full details.

Modern Tool Company, Erie, Pa.

AGENTS—The Prentiss Tool and Supply Co., 115 Liberty St., New York. Frank H. Czarniecki Co., 335 Fifth Ave., Pittsburg, Pa. O. L. Packard Machinery Co., 34 S. Canal St., Chicago, Ill., Milwaukee, Wis. C. W. Burton, Griffiths & Co., London, Eng. J Lambercier & Co., Geneva, Switzerland. Chandler & Farquhar Co., 34 Federal St., Boston, Mass.

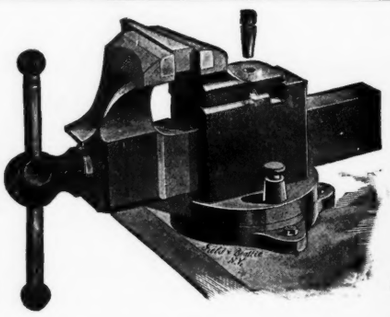
You Need the Pratt Chuck

The time saving, tool saving, trouble saving qualities of the Pratt Chuck count for a great deal when competition is close and the margin of profit small. It holds the drill or tap so firmly that there is no chance of slipping or working loose, insures quick and accurate work, and does not injure the shank of the tool. Simple and strong in construction and particularly adapted for high speed drilling.

Catalogue mailed on request.

THE PRATT CHUCK COMPANY, Frankfort, N. Y.

EUROPEAN AGENTS: Selig, Sonnenthal & Co., 85 Queen Victoria St., London, Eng.



Machinists' Swivel Vise

with self-adjusting jaw that is as strong and durable as any solid jaw, and a Swivel Bottom that gives any desired adjustment to right or left, and is solid and firm at any angle. We make all sorts of good vises, and have been leaders in this line for twenty years. Send for catalogue and price list.

Prentiss Vise Company
44 Barclay Street, New York

Agents for Great Britain, Chas. Neat & Co., 112 Queen Victoria St., London, E. C.

Almond Inclosed Pinion Drill Chuck

With pinion and gear teeth always in perfect mesh there is practically no opportunity for wear.

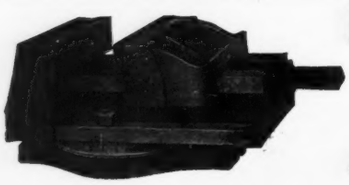
T. R. ALMOND MFG. CO.
ASHBURNHAM, MASS.
NEW YORK CITY. 40 Murray St.

OXOILOX Belt Dressing

Send for sample.

F. S. WALTON CO., Philadelphia, Pa.

Pressers and Refiners of NEATS FOOT OIL.



Plunket Improved Vises

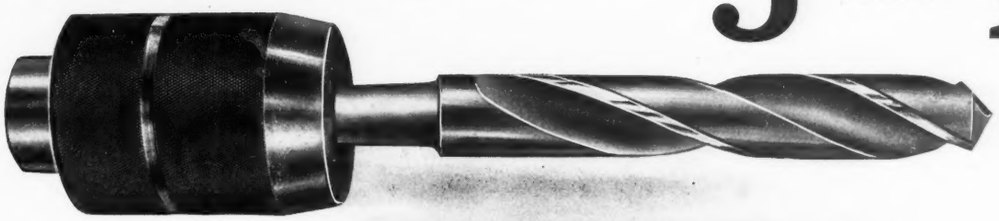
Made with Plain or Swivel Base

Specially adapted for the hard service of the machine shop. Can be used with every style drill-press, shaper and milling machine. Strongest construction, steel screw, steel faces to jaw, cast steel handle. Write for further information.

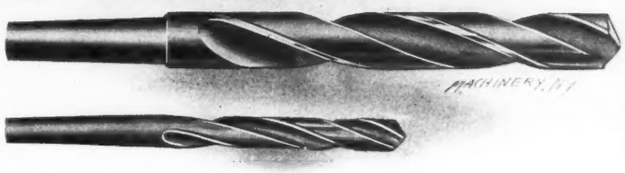
J. E. PLUNKET, Chicago, Ill.
47-49 South Jefferson St.

CUT OUT AND FILE the three SHOP OPERATION SHEETS in this number. Your set may be worth a hundred dollars to you some day.

THE MORROW 3 IN 1



Three Sizes of Taper Shanks for Tangless Drills



One Morrow Drill Chuck

A powerful chuck that will hold the smallest drill with the No. 1 and No. 2 taper and the largest drill of the No. 3 up to and including 1 1-4".

WHY use a special socket for each of No. 1, 2 and 3 tangless taper drills when one MORROW will serve the purpose?

WHY not save time and use your tangless drills by ordering one of our No. 5½ chucks?

WHY not use a tool that after the first cost the expense is reduced to the minimum?

WHY depend on tangless wonders when one chuck will do the trick?

WHY waste time in hunting sockets, drifts, spanners and wrenches when you can buy a hand releasing, automatically gripping MORROW?

WHY bother about your tangless running true when a power hacksaw is all that is required to remove the bad end. The MORROW will take care of the rest if 1½" of the shank remains.

FACTS WE GUARANTEE

Quick unresisting release by hand.
A positive powerful grip that never slips.
Large balls to take end thrust.
Bearings accurately ground to size.
No exposed threads or projections to catch the clothing or waste.
Drills run true from shank to point.

MORROW MANUFACTURING COMPANY, ELMIRA, N. Y., U.S.A.

LEVERAGE vs. MUSCLE

You won't waste time, strength and patience, setting drills in old fashioned chucks after you have made one trial of

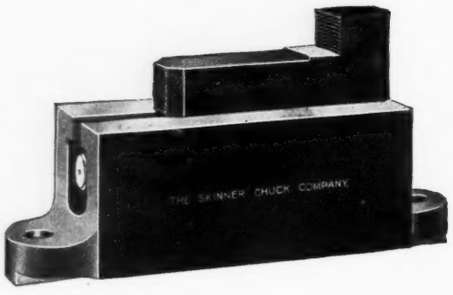
The Jacobs Improved Drill Chuck

No spanner, no holding the spindle. The Key does all the work, tightening or releasing the drills with a turn of the hand.

Write for our latest catalogue.

The Jacobs Manufacturing Company, Hartford, Conn.

Saving Substitutes



On large lathes and boring mills substitute Skinner Face Plate Jaws and save the difference in price of large and expensive chucks.

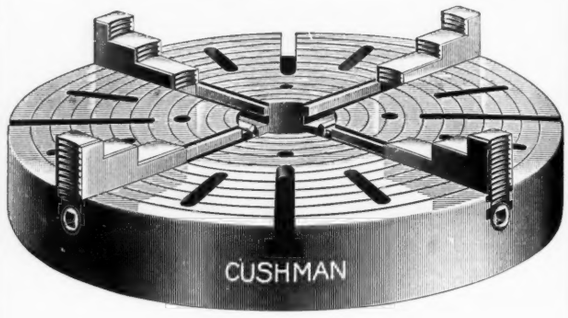
Note the rib on the bottom of jaws which adds to strength of jaw. Sets of three or four as desired.

Illustrated circular on request.

The Skinner Chuck Company

94 Reade St., New York City. NEW BRITAIN, CONN.

"CUSHMAN" CHUCKS



Lathe Chucks; heavy pattern for hard service.

Face Plate Jaws; for large machines.

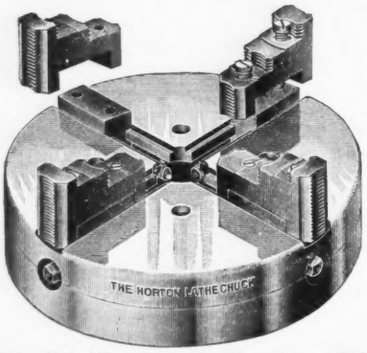
Also Drill Chucks.

Let us send you our catalogue and price list.

The Cushman Chuck Co.

179 Allyn St., Hartford, Conn.

HORTON COMBINATION CHUCK



Horton Chucks have had an enviable **reputation** for more than **fifty** years. They are durable, accurate, reliable. They are in use in all parts of the **world** where machine tools are used.

Chucks for Lathes, Drill Presses, Milling Machines, Cutting-off Machines, etc.

Shall we mail Catalogue?

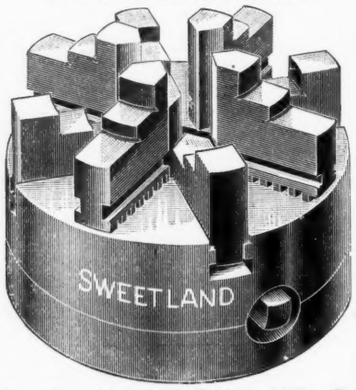
The E. Horton & Son Co., Windsor Locks, Conn., U.S.A.

Or Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Glasgow. Schuchardt & Schutte, Berlin, Cologne, Vienna, Stockholm, St. Petersburg and New York. Fenwick Freres & Co., Paris, France. Van Reitschoten & Houwens, Rotterdam, Holland.

ASK YOUR DEALERS FOR

SWEETLAND GEARED SCROLL CHUCK

STRONG—DURABLE—ACCURATE



The Hoggson & Pettis Mfg. Co.

New Haven, Conn., U. S. A.

DATA SHEET No. 3—MARCH, 1899

Formulas for strength and deflection of common springs.

Table: Strength of materials. Formulas and constants for loaded beams, etc.

Send for pamphlet giving complete list of Data Sheets 324 6x9 pages

HOISTS, New Patent Whip Patent Friction Pulleys. NONE BETTER MANUFACTURED BY

VOLNEY W. MASON & CO., PROVIDENCE, R. I., U. S. A.

Spur Geared Scroll Combination Lathe Chuck.

If you want the best Lathe or Drill Chucks—buy Westcott's

Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Geared Combination Lathe Chucks, Geared Universal Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.

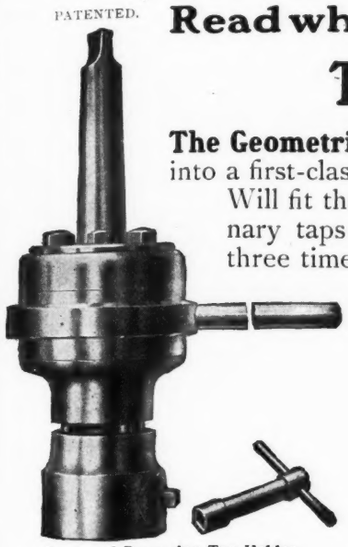
Strongest Grip, Greatest Capacity, Great Durability, Accurate.

WESTCOTT CHUCK CO., Oneida, N. Y., U. S. A.

Ask for catalogue in English, French, Spanish or German.

Little Giant Auxiliary Screw Drill Chuck.

PATENTED.



Improved Reversing Tap Holder.

Read what this reversing tap holder does and—

TRY IT AT OUR EXPENSE

The Geometric Improved Reversing Tap Holder converts a lathe or drill press into a first-class tapping machine. It operates in vertical or horizontal positions. Will fit the spindle of any drill press the same as a drill chuck. It uses ordinary taps and *does not* break them. It reverses automatically, backing out three times as fast as it cuts in. It works just as effectively when work is forced against the tap as when the tap is forced against the work.

Size 0 is for light work, size 1 handles work up to $\frac{15}{16}$", size 2 to $\frac{3}{4}$", size 3 to 1 $\frac{1}{4}$". Nos. 1 and 2 are especially fine for multiple and turret drills and for drilling and tapping at one handling.

Let us send you one on trial.

The Geometric Tool Company

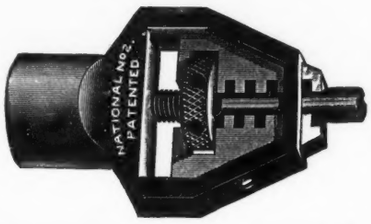
Westville Station, New Haven, Conn.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. Schuchardt & Schutte, Vienna, St. Petersburg, Stockholm, Berlin.

Oneida National Independent Chuck

National Drill Chuck

Made entirely of Steel. Has no Equal.

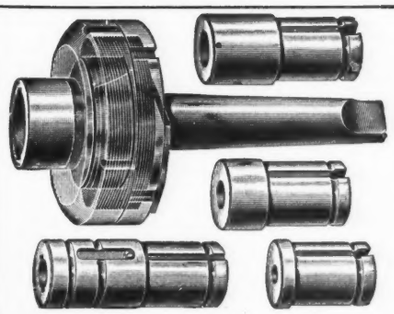


Does not get Out of Order.

If you have a dirty job, try it. Money refunded if not satisfactory.

Oneida National Chuck Co.

ONEIDA, N. Y.



THE

Safety Drill & Tap Holder

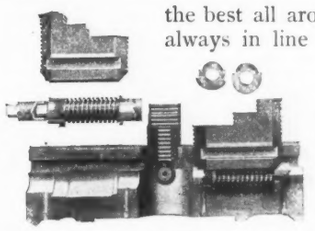
is the only attachment for the purpose that gives universal satisfaction, and is

UNEQUALLED in Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

Nothing to Break or get out of Order. Made in 4 sizes, covering from 0 to 2½ in. diameter.

The Beaman & Smith Co., Providence, R. I., U. S. A.

The Cincinnati Independent Chuck



the best all around lathe chuck on the market Jaws always in line and perfectly rigid. Hardened steel bushings for screws give three times the wear of ordinary bearings and overcome all difficulty with end play on screws. Four reversible jaws.

SEND US YOUR ORDERS

Chicago Office: 89 W. Randolph St.
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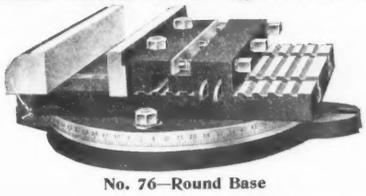
THE CINCINNATI CHUCK CO.
CINCINNATI, OHIO

UNION PLANER CHUCKS

ROUND BASE AND SQUARE BASE

Made in Eight Sizes.



All Thrust Plates Hardened.

Screws made of Tool Steel.

No. 76—Round Base

UNION MANUFACTURING COMPANY

26 Cortlandt St., New York — **New Britain, Conn., U. S. A.**

BIND YOUR SHOP OPERATION SHEETS

The Binder for the Shop Operation Sheets will hold 150 sheets, and the price is twenty-five cents delivered.

THE INDUSTRIAL PRESS, 49-55 Lafayette Street, New York City, U. S. A.

LET US CUT YOUR SCREWS

We Make Screw Cutting our Exclusive Specialty

We make Screws for all purposes; it does not matter what the length, the diameter, pitch, or style of thread, our complete facilities and improved methods insure the most accurate results. We can save you money on screws for all classes of machine tools—power screws, lead screws, feed screws—and can furnish duplicates in any number, all alike and interchangeable. *Write us for full particulars.*

The Screw Cutting Company of America, Philadelphia, Pa., U.S.A.

Drive your screws with the Reynolds Automatic Screw Driver

It is strong, simple, durable, does not require skilled labor and will drive wood or machine screws anywhere they can be driven by other methods and in many cases without boring.

Screws are fed automatically and the output of the machine is only limited by the ability of the operator to handle it. Does not mar screw heads or work.

Made in various sizes and types to suit different classes of work.

A machine that pays its way—send for full description.

Reynolds Machinery Co.
MOLINE, ILL.

Downward Belting

THE COMING THING
IN THE POLISHING ROOM

Of course it's a wide change from the old way, but after all, its the logical sequence, you'll admit. Belts in the room are dangerous, they create belt draughts, and they are in the way. Belts, if led below, are not dangerous, they create no draught, and they are out of the way.

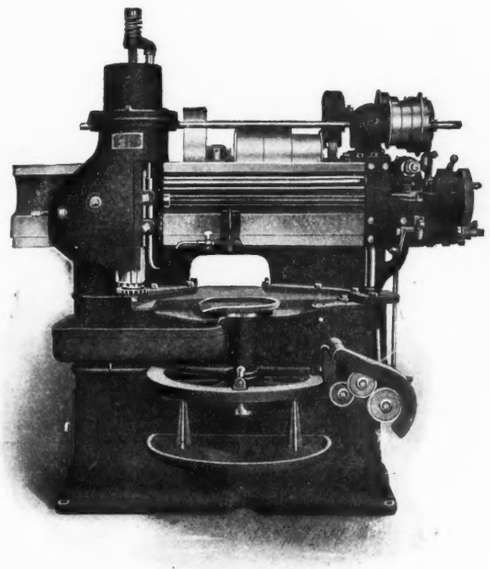
The Whitney Polishing Lathe is the pioneer that shows the way to safe polishing under healthful conditions. We can post you promptly if you will let us.

THE NEW BRITAIN MACHINE CO.
NEW BRITAIN, CONN.

For work and wear, for clean, fast, accurate cutting, for quality of material and superior design, specify NATIONAL CUTTERS. High Speed or Carbon Steel. Standard Sizes in Stock.

Booklet "A" covers the line.

THE NATIONAL TOOL COMPANY, Cleveland, Ohio

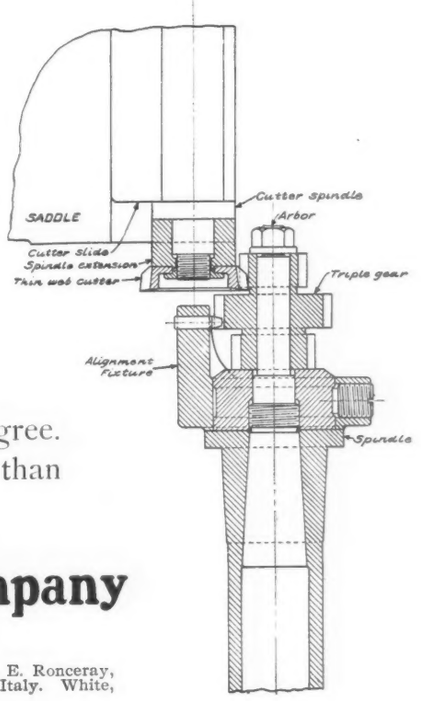


Quiet gearing is an essential feature of a high-grade automobile; therefore, this gearing should be cut by the Gear Shaper System

The requirements as to accuracy are much more exacting than ever before, but this only tends to increase the popularity of the Gear Shaper. No living man can harden a piece of steel, and especially high speed steel, without springing it, and therefore no man can cut accurate gears with unground cutters. If you own a high-grade car, it's heavy odds that the gears were cut by the Gear Shaper System. Write us the make and we'll tell you, or ask the manufacturer.

We illustrate herewith the method of cutting the "triple gear." This type of gear is an essential part of the planetary transmission of the automobile. In order to assemble two "planets," a tooth of each of the three gears must be in exact alignment. This is accomplished by the use of the alignment fixture shown herewith.

It will be noted in these cases that by the use of our "draw-in arbor," the blank is clamped to the work spindle, and not, as by ordinary practice, to the arbor, making the stiffest combination possible.



The Gear Shaper is equally valuable in any shop manufacturing high-grade gears, especially where low cost is important, for in this machine accuracy and speed are combined to an unusual degree. The Gear Shaper is 25 to 50 per cent. faster than any other machine on the market.

The Fellows Gear Shaper Company

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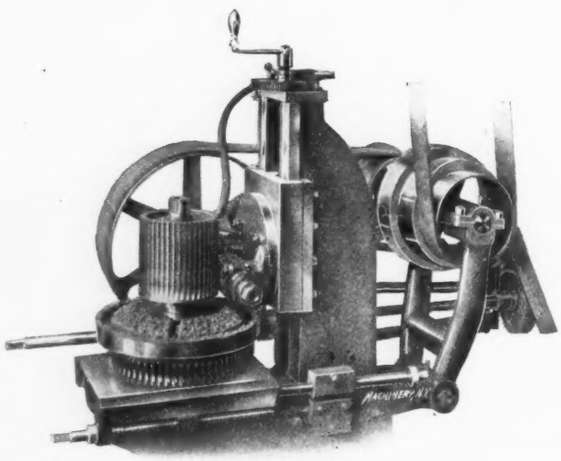

The Farwell Automatic Gear Hobbing Machine was designed for cutting transmission gears, so is right at home on the six pitch chrome nickel steel gears shown in this cut.

We back up our estimates on your gears with quotations on the work. It costs so little to do the work on this machine that we will gladly cut a few gears free of charge, just to show you how smoothly they run.

Catalog No. 58-M tells more.

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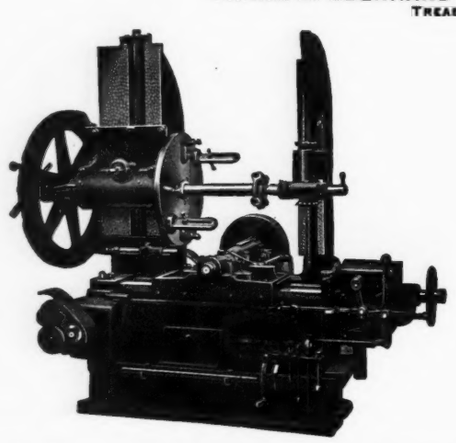

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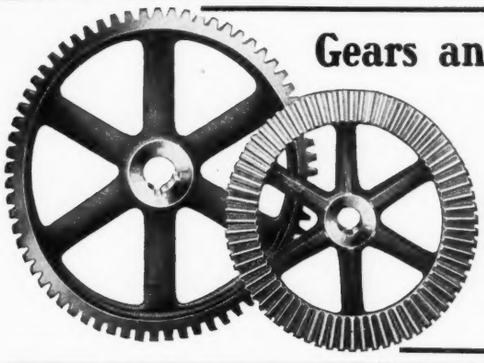

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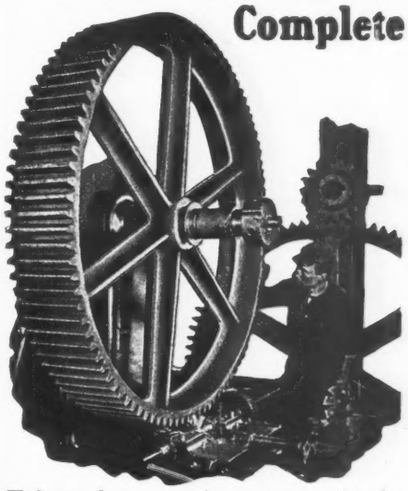

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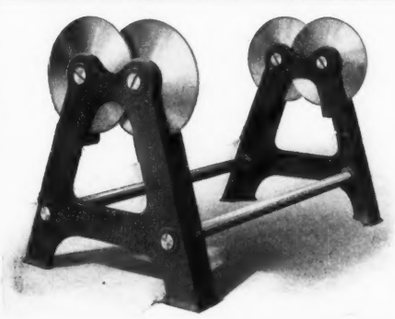

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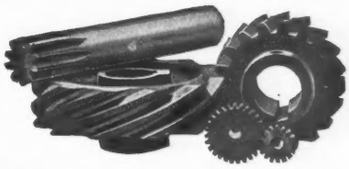

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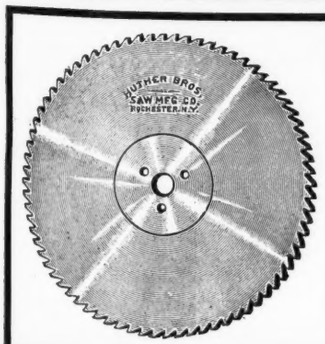

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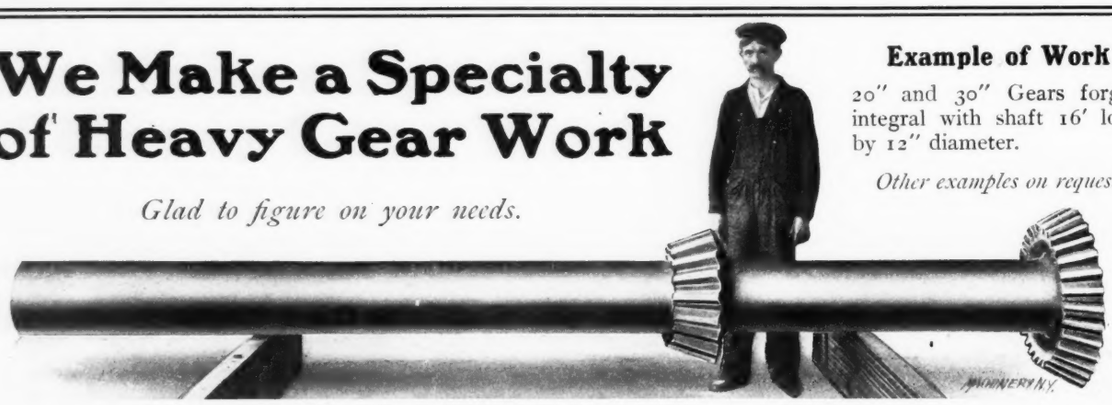

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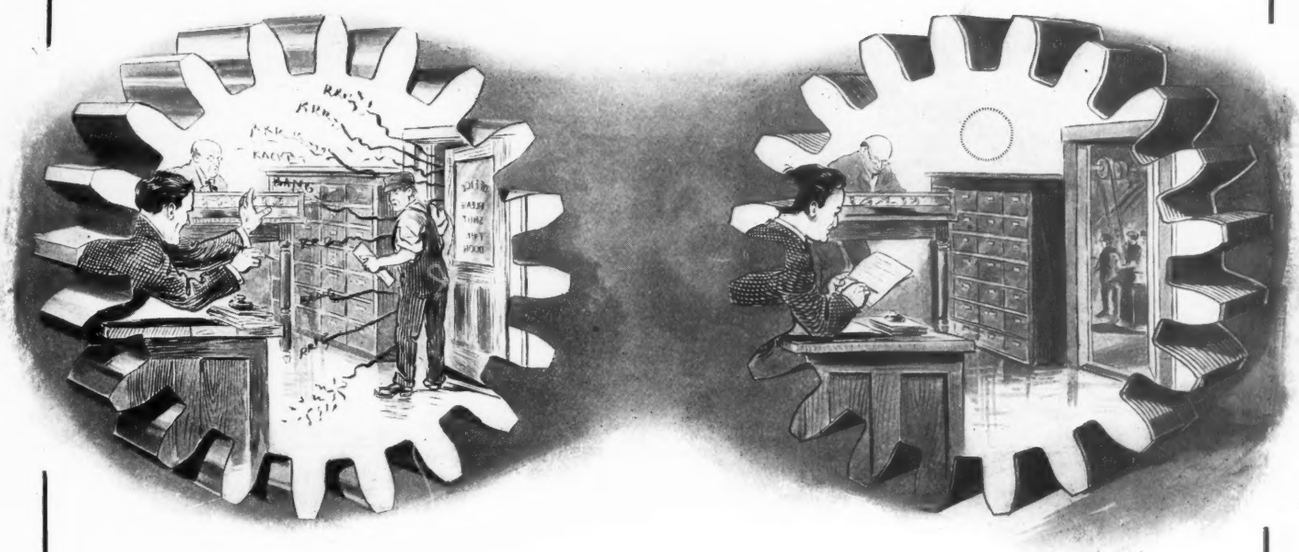

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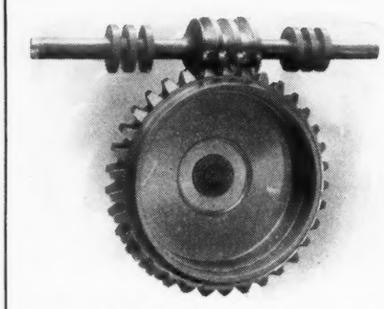

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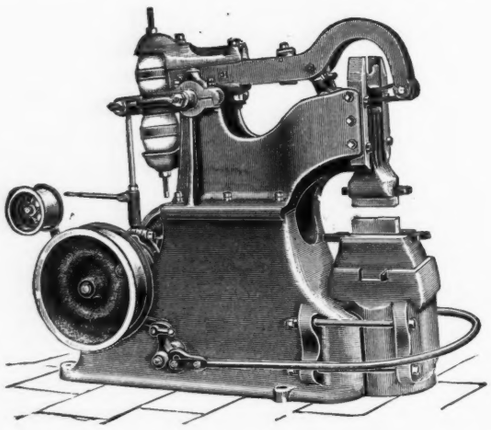

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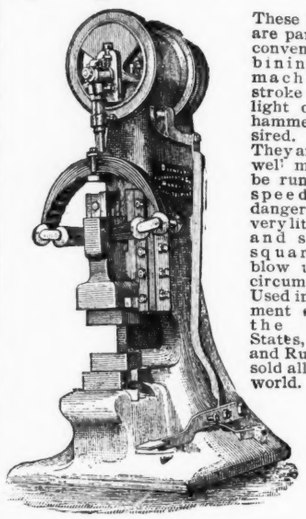

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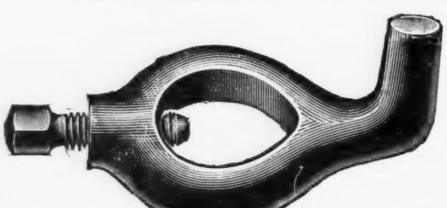

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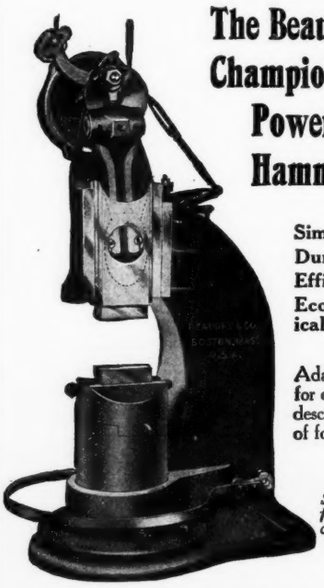

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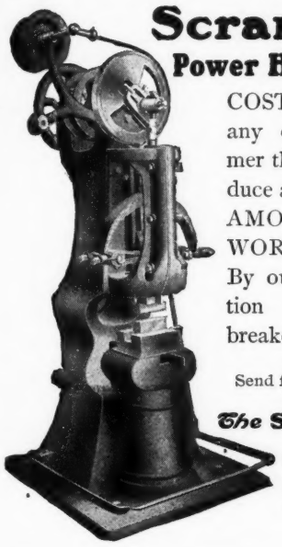

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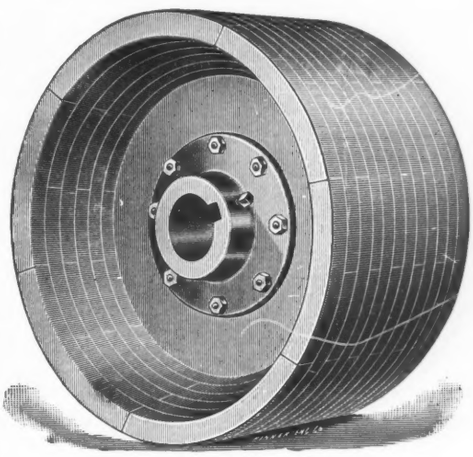

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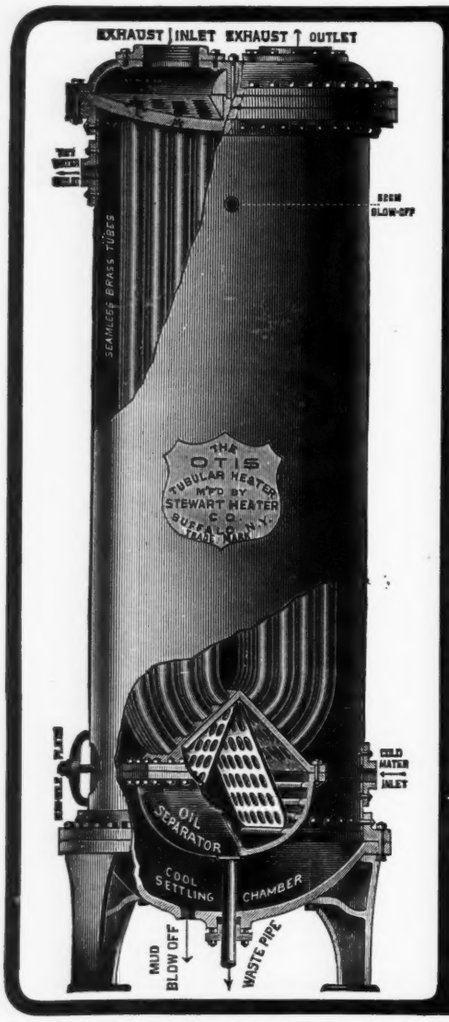

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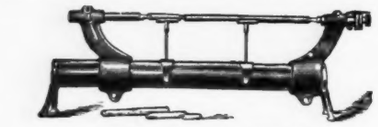

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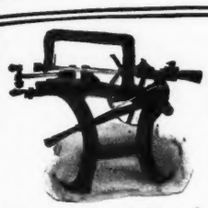

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Saws straight. It has a **quick acting vise** that saves time, a device that lifts saw to any angle, holds it in position, allowing both hands free in measuring. Slide bar is square steel set on the quarter which keeps saw motion straight. The cut is controlled by eccentric on crank, fitted to an arm automatically pressing and releasing against a coiled steel spring.

The only saw on the market with these valuable improvements.

Capacity 4x4 in. Blade 12 in. Weight 110 lbs.

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Power Hack Saw Machine

Cuts off a 3" round steel bar in 8 minutes or 1000 ¾" rods per hour.

Compare it with your present method of cutting.

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cuts all kinds and shapes of cold metal

RAPIDLY,
STRAIGHT,
CHEAPLY.

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Robertson's 1909 Improved ROYAL Power Hack Saws

Will cut MORE metal at less cost than any other machine and keep right on doing it.

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We guarantee every machine.

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BALL BEARINGS

1-4 in. Shaft and up.
No fitting, just push them on.
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And their belts pliable and in perfect condition at all times.

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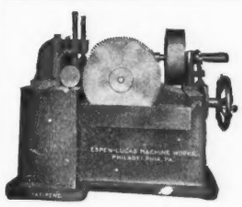
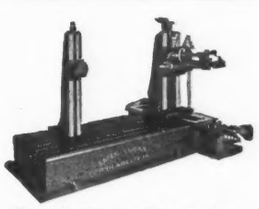


No. 7 Bar Cold Saw



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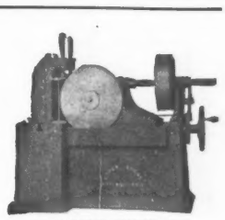

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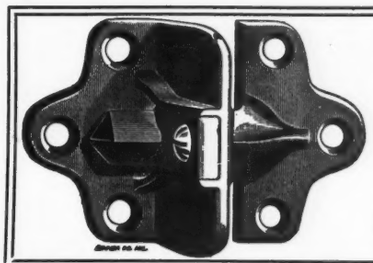

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saves time, expense, and makes true castings. Quickly applied and easily adjusted.

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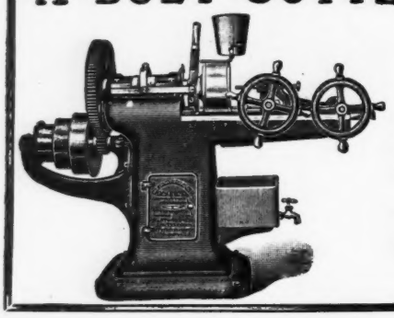

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1. Simplicity of the head; Only four parts, consequently,
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7. No machine turns out work more rapidly.

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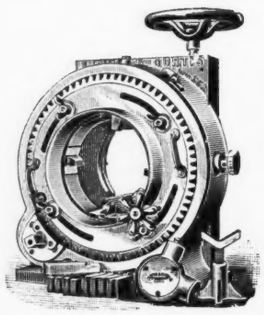
"Pipe Threading Made Easy"

Should be the motto of the Forbes Patent Die Stock



Because with this machine one man, unaided, can cut off and thread pipe up to 15" sizes, by hand—just the same kind of job that under other conditions would require **four** men—and perhaps a boy to help. Besides its efficiency, the Forbes has the advantage of being readily taken from place to place, can be operated in the most cramped spaces, is complete in itself, very durable and both simple and rapid in operation.

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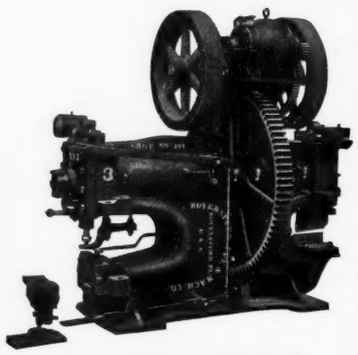

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Our Improved No. 6 Standard Machine with patent adjustable expanding die head and interchangeable chasers

Cuts off and threads pipe 2½ to 8 inches. A special arrangement of gearing permits ample power and suitable speeds for working the various sizes of pipe and avoids the use of large pulleys and tight belts. Every improved feature for rapid and accurate operation.

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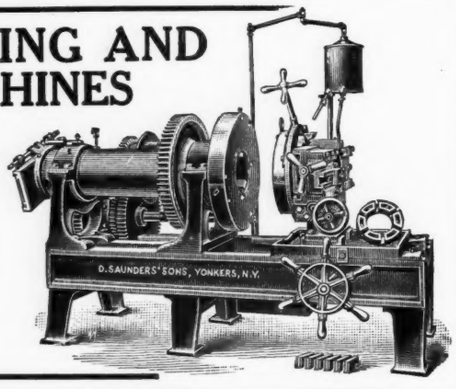

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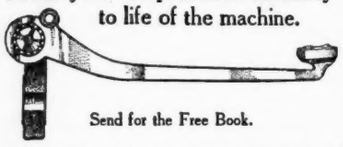

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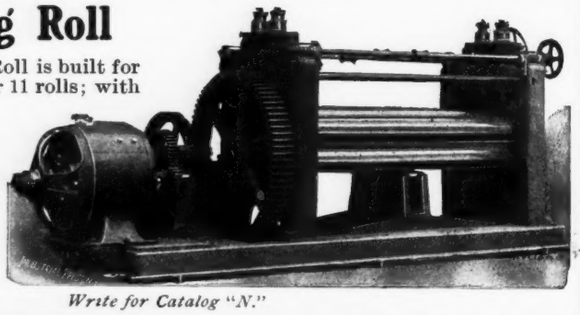

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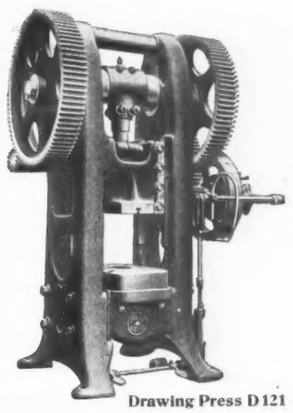

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Railroad and Structural Shops
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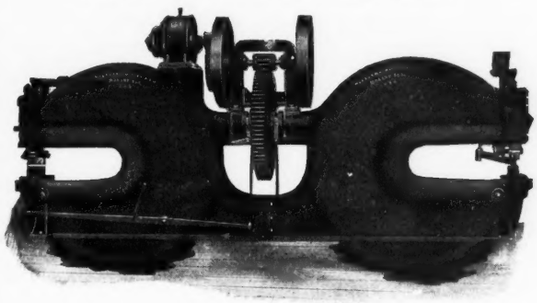

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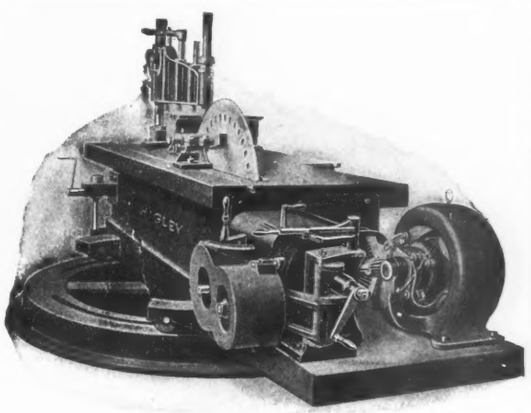

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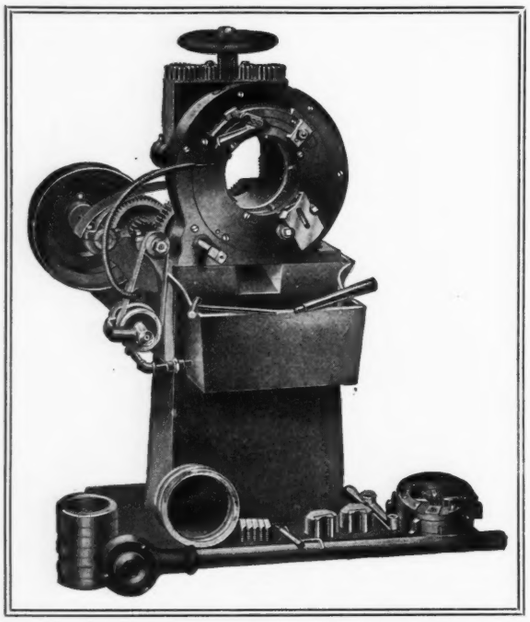

Nothing tells like the test of actual working trial.

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That is why we are quick to say "We send this MERRELL PIPE THREADING AND CUTTING MACHINE anywhere in America for 30 Days' Free Trial."

If the Merrell does not make good in these 30 days, send back the machine at our expense, and get your money back.

But we know the Merrell *will* make good because it *has* made good.

Write us for full particulars about the Merrell, tell us your Pipe Machine requirements and we will build—if necessary—a machine that will meet every want.

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B AND K PIPE MACHINES ARE BEING USED IN ONE CITY

And the number increasing at a healthy rate. A good showing, don't you think? Lest you forget, we repeat

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REVERSIBLE—Not necessary to remove wrench from pipe. Just loosen chain and swing jaws to opposite side.

STRENGTH—Handle designed to give great strength. No drawing stress on jaws as the chains are anchored to the handle. Jaws and Chains made of the best material known for this purpose. This feature of **superior strength** also allows **increased capacity** and insures **safety** of the workman.

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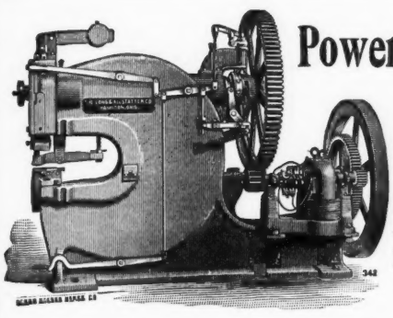

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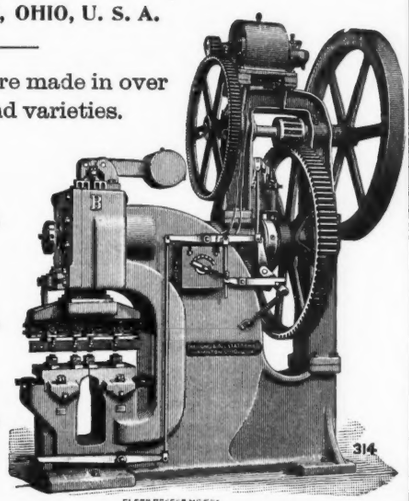

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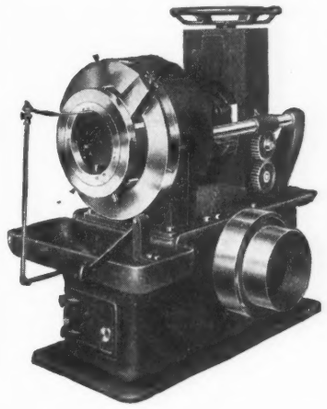

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HAND POWER—BELT POWER
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1-4 to 8-inch pipe.

Adaptable to all conditions and locations.

When you install the Loew Victor, the knowledge and satisfaction, that you have secured positively the

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With efficiency as well as beauty.

Heavy—none more so; bed cast in one piece, no stands or legs to work loose. No oil soaked floors; fire risk reduced.

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Deep chasers cutting long taper perfect threads in one cut as easily on steel as on iron pipe.

Let us prove to you that the higher cost of a modern tool is justified by the character and quantity of its product. Circulars for the asking.

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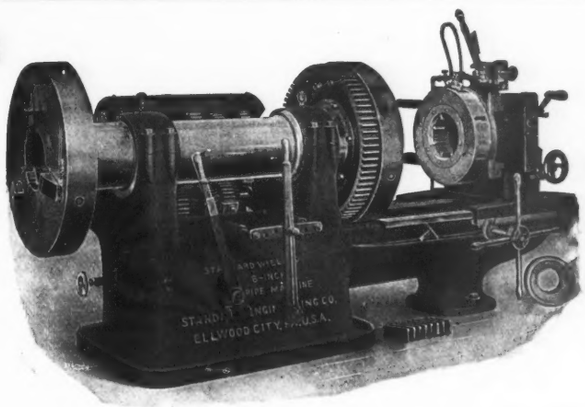

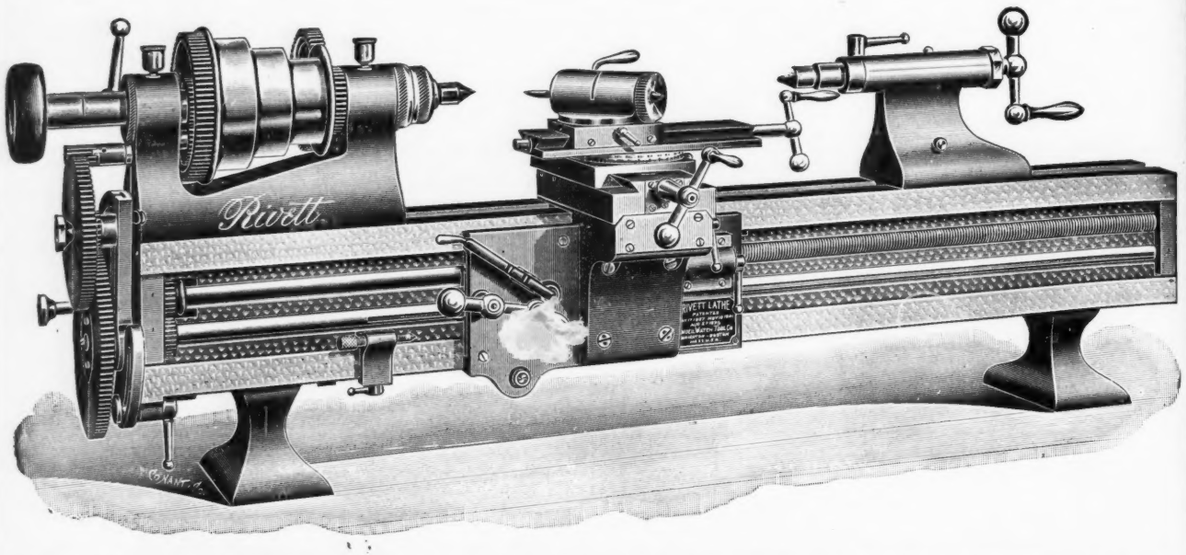

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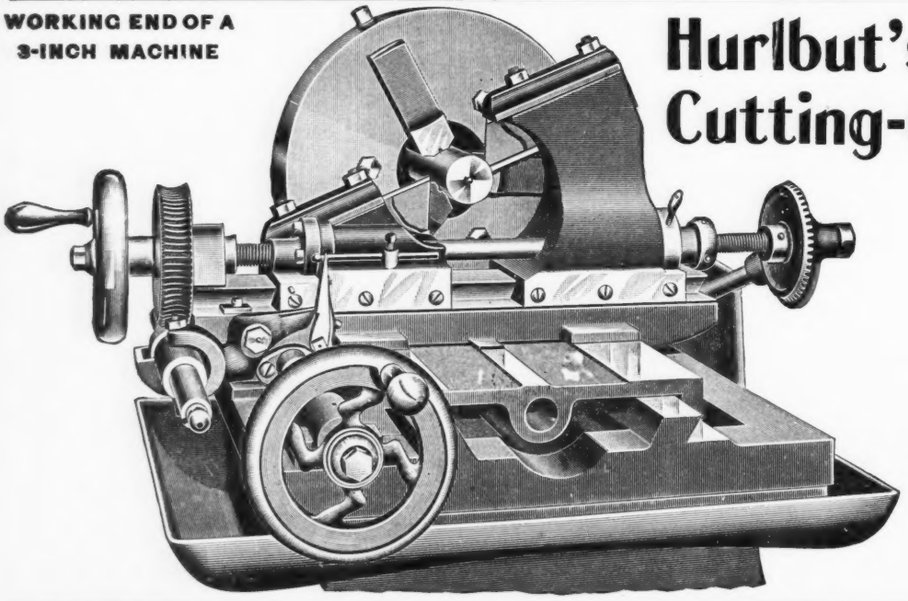

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Made in 2-inch, 3-inch, 4-inch, 5-inch, 6-inch, 8-inch and 10-inch sizes.

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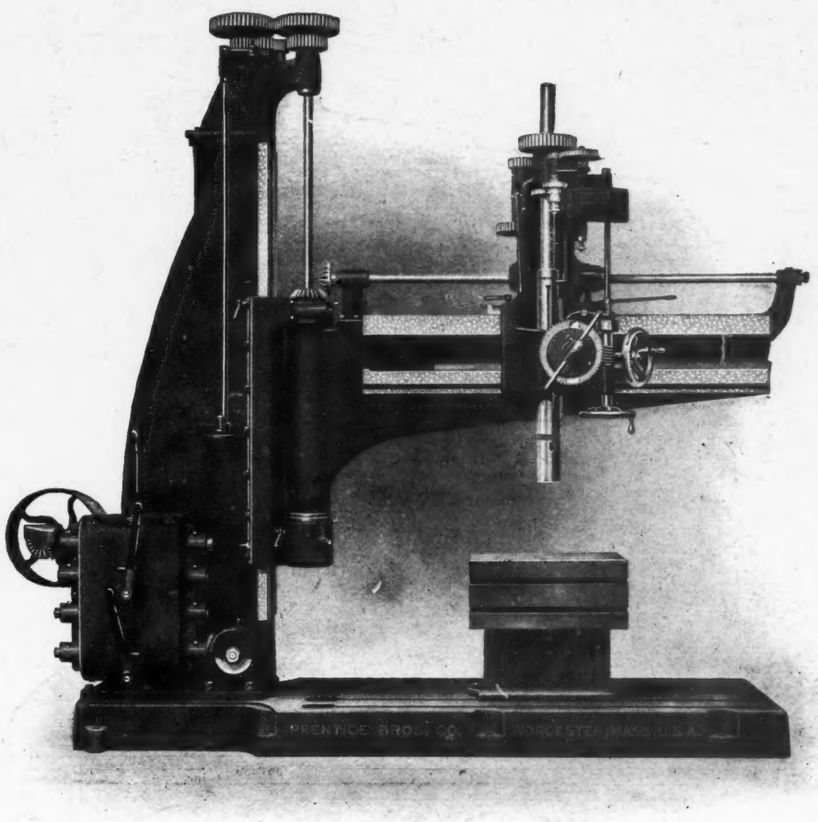

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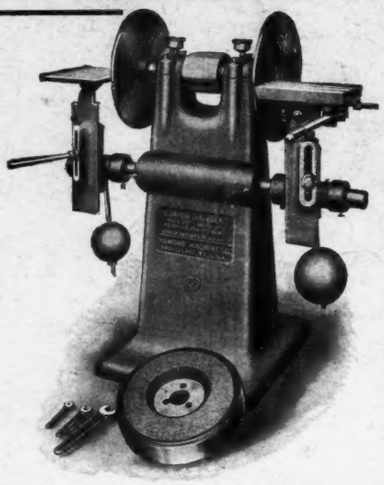

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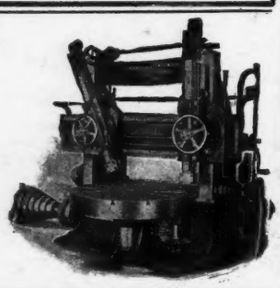

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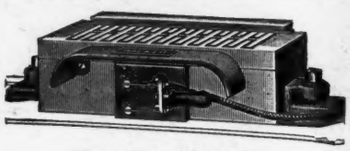

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